Coastal Zone Management Plan

for the Ballina Shire Coastline

quality solutions sustainable future

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for the Ballina Shire Coastline

Prepared for: Ballina Shire Council

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Glossary

Beach	Has the same definition as the CP Act: *means the area of unconsolidated or other readily erodable material between the highest level reached by wave action and the place where tidal or lake waters reach a depth of 10 metres below Australian Height Datum.*
Beach erosion	The offshore movement of sand from the sub-aerial beach during storms or an extreme or irregular event.
Coastal erosion emergency event	A situation in which beach erosion is imminent, occurring or has occurred, and the beach erosion endangers, or threatens to endanger the safety or health of people or destroys or damages, or threatens to destroy or damage any property and which requires a significant and coordinated response.
Coastal hazard	Defined in the Coastal Protection Act 1979 (section 4) as: a) beach erosion b) shoreline recession c) coastal lake or watercourse entrance instability d) coastal inundation e) coastal cliff or slope instability f) tidal inundation g) erosion caused by tidal waters, including the interaction of those waters with catchment floodwaters.
Coastal inundation	Coastal inundation is the storm-related flooding of coastal lands by ocean waters due to elevated still water levels (storm surge) and wave run-up.
Coastal protection works	Activities or works to reduce the impact of coastal hazards on land adjacent to tidal waters and includes sea walls, revetment and beach nourishment.
CP Act	*Coastal Protection Act 1979*
CHDS	Ballina Shire Coastal Hazard Definition Study (WBM, 2003)
CZMP	Coastal Zone Management Plan
EASP	Emergency Action Sub Plan
MSL	Mean Sea Level (Australian Height Datum)
OEH	Office of Environment and Heritage (formerly DECCW – Department of Environment, Climate Change and Water)
Shoreline recession	A net long-term landward movement of the shoreline caused by a net loss in the sediment budget.
Sub-aerial beach	The beach above mean low water level
Tidal inundation	The inundation of land by tidal action under average meteorological conditions and under any combination of astronomical conditions.

Executive Summary

Section 1: Introduction

The coastline of the Ballina Shire is a dynamic environment subject to the natural processes of coastal erosion and accretion.

This report, the Coastal Zone Management Plan for the Ballina Shire coastline (CZMP), represents the culmination of various studies and consultative processes, including:

- *Ballina Coastline Hazard Definition Study* (WBM, 2003) and the *Updated Coastal Hazard Areas for Ballina Shire: Stage 1 – Preliminary Update* (BMT WBM, 2011) concentrating on Lennox Head;
- *Ballina Coastline Management Study – Stage 1 Values Assessment* (GeoLINK, 2007);
- *Ballina Coastline Management Study – Stage 2 Management Options Assessment* (GeoLINK, 2008); and

This CZMP focuses on maintaining or improving the ecological, cultural, recreational, and economic values that are exposed to the following coastal hazards:

- Beach erosion, due to offshore movement of sand from the sub-aerial beach during storms or an extreme or irregular event;
- Shoreline recession due to sediment budget deficits (i.e. more sand leaving a beach than entering it) and sea level rise; and
- Coastal inundation, resulting from extreme ocean storm events, overtopping dunes and inundating land behind the dunes.

Management of coastal ecosystems and community uses of the coastal zone has been thoroughly considered in various other plans. In cases where ecological, cultural, recreational, and economic values are *not* exposed to coastal hazards this CZMP complements or refers to, without duplication, these plans, in particular the Ballina Coastal Reserves Plan of Management (CRPOM) and the Precinct Plans that underpin it.

Section 2: Key findings of the Coastline Hazard Definition Study and the Coastline Management Study

WBM (2003) and BMT WBM (2011) and estimated the potential threat from coastal hazards including:

- Beach erosion
- Shoreline recession; and
- Coastal inundation.

For planning purposes, coastal hazards were estimated for the immediate term (comprising beach erosion only), and for 50 year and 2100 planning period (comprising combinations of beach erosion and shoreline recession). Coastal inundation was not found to be a significant hazard.

There are inherent uncertainties in the estimation of future coastal erosion over timeframes spanning close to 100 years. These uncertainties are accommodated by a conservative approach to developing the recommended management actions and the recommendation for further and on-going monitoring of coastal processes.

Beach erosion estimates for landward movement of the shoreline range between 20 m and 45 m.

Sediment budget deficit erosion estimates for landward movement of the shoreline by 2050 range between 2.5 m and 25 m, and by 2100 the estimates range between 5 m and 50 m.

The sea level rise erosion estimate for landward movement of the shoreline by 2050 is 20 m, and by 2100 45 m.

Sea level rise erosion estimates are derived from a simple application of the Bruun Rule and adoption of the sea level rise estimates presented in *NSW Sea Level Rise Policy Statement* (DECCW, 2010). These sea level rise estimates are for 0.4 m by 2050 and 0.9 m by 2100.

These erosion mechanisms typically occur together with total recession distance an additive combination of these estimates.

The erosion estimates assume no management intervention and, at Lennox Head north of Byron Street no mitigating influence of the existing buried seawall or other existing structures.

Values and threats

GeoLINK (2008) identified many ecological, cultural, social, recreational and economic values ascribed to the Ballina coastline by the community, and where these values might be threatened by coastal erosion hazard.

Ecological values considered to be under threat from coastal erosion include the following.

- Around 76 ha of coastal heath may be lost by 2050 (around 160 ha by 2100).
- Lake Ainsworth may be subject to oceanic breakthrough within 50 years.
- Sandy beaches may be lost 'against' hard structures such as seawalls and natural cobble fields, particularly in Lennox Head and at Boulder Beach.
- Intertidal rock platforms may be subject to significantly altered inundation regimes. This will result in major ecological shifts where there is limited 'space' for intertidal species to move to more suitable ecological niches.

Some local recreation values may be lost such as those ascribed to the beach at Lennox Head due to the beach being lost 'against' the existing seawall and constructed levee if nourishment does not occur.

It is not possible to quantify the potential reduction in economic value of the Ballina coast as a result of coastal erosion due to the diversity and complexity of components that make up this value. The estimated current annual economic value of the Ballina coast is $18M, and the estimated current annual recreation value of the beach (not coast), is $5.1M. These values are likely to reduce overall as a result of coastal erosion.

It is estimated that around $83M and $122M (present value) of private and community assets are under coastal hazard threat by 2050 and 2100 respectively.

Section 3: Recommended Management Actions

Management actions are recommended to mitigate against

- Beach erosion; and
- Shoreline recession; and
- Coastal inundation.

Shoreline recession generally occurs over the long term, while beach erosion is generally the result of a severe storm event, or a closely-spaced series of such events, that can occur at any time. Beach erosion is often followed by a period of accretion.

Cost-effective management of coastal erosion requires a set of complementary short-term (emergency) and long-term management actions to coordinate preparedness, mitigation and recovery in order to maintain coastline amenity.

Coastal Erosion Emergency Events

Coastal erosion emergency events are most likely to arise when severe storm conditions (cyclones or low pressure systems) generating strong onshore winds and large waves, coincide with high spring tides. Coastal erosion emergency events may also occur under relatively benign conditions where, due to the significant lowering of a beach profile as resulting from natural processes, waves are able to scour the back beach erosion escarpment resulting in landward recession of the escarpment. Coastal erosion and or inundation may exacerbate risk to development, infrastructure, and/or persons.

To manage these risks Council has prepared an Emergency Action Subplan for Coastal Erosion (EAS) that is separate but related to this CZMP. The EAS details actions to be carried out by Ballina Shire Council (Council), in response to a coastal erosion emergency event.

North and Central Seven Mile Beach

The broad management objective adopted for this beach unit is to allow coastal processes to proceed under monitoring. Coastal erosion is expected to take the form of a gradual landward movement of the beach and dune system without a substantial change to the nature or extent of these environments, but resulting in a net loss of the coastal heath. No development is under coastal hazard threat in this beach unit.

Lennox Head – North of Byron Street

The broad management objective adopted for this beach unit is to protect development landward of the beach rather than remove development and allow erosion to proceed, i.e. protect rather than retreat. Ideally, the method of protection should provide for a natural beach and dune system that will both act as a buffer to accommodate erosion within the area seaward of development during storm events and be available for recreational and environmental purposes.

In response to Council's decision to protect rather than relocate assets, GeoLINK (2008) identified that the most effective strategy for this beach unit is the *Beach Nourishment with Seawall* option.

BMT WBM (2011) estimates that, in the absence of any management intervention and any mitigating effect from the buried seawall or exiting structures:

- beach erosion may affect Pacific Parade between Byron Street and Lennox Street in the immediate term but only as a result of the effects a zone reduced bearing capacity; and
- coastal hazards are estimated to affect assets as far landward as Cliff Murray Lane by 2050 (including a breach of Lake Ainsworth), and as far landward as Stewart Street by 2100.

Full implementation of all works required to protect against potential future long term recession is not required immediately. Thus the management plan for this beach unit comprises two main steps, investigations and monitoring followed by staged implementation of on-ground works.

Step 1 relates to investigations and monitoring and includes:

- (**Section 3.4.3.1**) Investigate feasibility for a long term sand supply for beach nourishment as a contingency measure to cater for the probability that the historical shoreline recession will continue into the future, exacerbated by sea level rise.
- (**Section 3.4.3.2**) Establish a comprehensive program of beach and dune monitoring integrating various monitoring methods to identify site specific beach processes, short and long-term trends, and trigger points for initiating detailed monitoring and protective works.
- (**Section 3.4.3.3**) Conduct coastal engineering assessment of the structural capacity of the existing buried seawall between Byron Street and the Lennox Head Alstonville Surf Lifesaving Club (SLSC) and the Lake Ainsworth Sports and Recreation Centre (LASRC). This investigation will identify requirements for upgrading their construction to a standard that will provide protection coastal hazards as a 'last line of defence'.

Step 2 relates to on-ground works of beach nourishment and seawall upgrade/ construction as informed by Step 1.

A preliminary concept design of the beach nourishment works has been determined on the basis that the long-term trend of shoreline recession will continue, and its rate is likely to increase in future due to sea level rise. However, the possibility that the shoreline recession rate may stabilise and/or recover naturally is provided for by a strategy that includes ongoing monitoring and 'trigger points' to indicate the need for major remedial works.

Management Plan – Investigations and Monitoring

Confirmation of suitable sources of offshore sand, and the associated design and approval of a program for extraction and placement of that sand, is likely to be a complex and lengthy exercise. Sand nourishment is the primary means by which assets will be protected under this CZMP.
Therefore **Management Action 2013/1** recommends that these investigations are started immediately, followed by design and planning (**Management Action2015/1**), and approvals (**Management Action ST1**) to ensure that works can commence when the trigger point is reached (see **Section 3.4.4.1**). Having the investigation, design, planning and approvals in place is also necessary for any seawall works to commence under this CZMP (see **Section 3.4.4**).

A clear picture of the changing nature of the beach is critical for timely and cost-effective management, primarily by means of identification of the trigger point for implementation of protective works. There are various monitoring methods available for Council to determine both short and long-term trends of shoreline recession rates; current condition of the beach and dune; and whether trigger points have been reached to initiate detailed monitoring or protective works. These include:

- Photogrammetric analysis (minimum basis of monitoring program);
- Land-based surveys;
- Low cost beach monitoring;
- Bathymetric surveys; and
- Coastal conditions monitoring system.

The existing seawall buried under the dune east of Pacific Parade was built between 1977 and 1980. As its structural design, construction and present condition are unknown **Management Action 2014/2** requires that it be assessed with respect to current best practice design standards by a suitably qualified and experienced coastal engineer.

Management Plan – Protective Works

In principle, the trigger for implementation of beach nourishment is reached when the volume of sand available in the beach profile seaward of the 'line of protection' is less than 200 m³/m. Identification of when this trigger point is reached requires:

- determination of the 'line of protection', landward of which property or infrastructure is to be protected and along which a seawall would ultimately be constructed;
- quantification of the sand that is available seaward of that line and above the limiting design storm profile; and
- assessment of the trends in the volume of sand available above the limiting design storm profile.

The beach profile at the time of nourishment and, particularly, the results of the monitoring and identification of trigger points for action will guide nourishment volumes and locations. However, for planning purposes and on the basis of presently available information and assuming a fully depleted beach, it is considered that an initial quantity of about 600,000 m³ will be necessary. The required nourishment volume per lineal metre of beach is expected to vary from 500 m³/m seaward of Byron Street to 250 m³/m seaward of the Lake Ainsworth Sport and Recreation Centre (LASRC).

Under this CZMP, works on upgrading or reconstructing the existing buried seawall, or installation of a new seawall, *cannot* commence without a beach nourishment program in place for this beach unit.

The beach nourishment program described in **Sections 3.4.4.1** and **3.4.4.2**, subject to detailed design, would be adequate to prevent damage to assets from coastal hazards. However, a seawall as a secondary landward 'last line of defence' along this beach unit is also recommended because:

- The coast may be subject to particularly severe erosion conditions, or a series of beach erosion events, that result in a volumetric loss exceeding the current estimate of 200 m³/m described in **Section 3.4.4.1**;
- The timely provision of sand for beach nourishment cannot be guaranteed; and
- The assets under potential coastal hazard threat, including Lake Ainsworth, are of significant value.

Section 3.4.3.3 provides a basic outline of the concept design requirements of the seawall. The alignment of the seawall will follow the 'line of protection' landward of which property or infrastructure is to be protected. It is recommended that the seawall is aligned as far landward as possible to maximise the potential to retain a sandy beach seaward of the wall.

Once a beach nourishment program is in place, it is recommended that seawall works commence following a beach erosion event that exposes the existing seawall, based on the following reasons:

- Significant excavation of the *existing* dune profile would be required to implement seawall works, whether these works comprise repair, reconstruction and/or relocation of the existing buried seawall, installation of a new seawall, or some combination. The process of beach erosion will do much of the excavation that is necessary for the seawall works.
- North of Foster Street the immediate hazard line is approximately 20 m seaward of the Pacific Parade roadway indicating it is currently extremely unlikely that major assets will be damaged by beach erosion, even if more than 200 m³/m of sand is lost in the beach erosion event. Thus, under the estimates put forward in BMT WBM (2011), there is currently very little risk in waiting for the beach erosion event to occur.
- The natural capacity of the dune will be severely reduced during the works period as a result of the excavation, whether it is done by beach erosion or mechanically. While a storm resulting in significant beach erosion can occur at any time, the historical record shows that such events tend to be isolated. Hence it is less likely that a beach erosion event will occur shortly after one has just occurred.

Lennox Head, south of Byron Street

The broad management objective adopted for this beach unit is to protect development landward of the beach rather than remove development and allow erosion to proceed, i.e. protect rather than retreat.

In response to Council's decision to protect rather than relocate assets, GeoLINK (2008) identified

that the most effective strategy for this beach unit is the *Beach Nourishment with Seawall* option.

The existing seawall and levee, if appropriately monitored and maintained, are considered adequate to withstand a large coastal erosion event (or series of smaller events). Thus, theoretically there is no coastal hazard threat to assets in this beach unit. However, the levee appears to have slumped in places from a design height of 5.5 mAHD to around 4.8 mAHD, mainly near access points.

A number of management actions are recommended for this beach unit, some of which are effectively extensions of those recommended for Lennox Head – North of Byron Street. The management actions include:

- Various monitoring and dune management actions;
- Conduct coastal engineering investigation to determine condition and adequacy of constructed levee;
- Upgrade constructed levee on basis of investigation under, including importation and stabilisation of additional sand to ensure that the crest elevation of the constructed levee is returned to the design level of RL 5.5 mAHD;
- Investigate, re-design and install new stormwater drains discharging at the constructed levee;
- Carry out beach nourishment in conjunction with nourishment of the beach further north (if carried out) within ecological constraints associated with the adjacent reef areas to improve beach amenity and access;
- Monitor and maintain the structural integrity of the existing seawalls into the future; and
- Design and install a boardwalk on the existing seawall between Rayners Lane and Byron Street if public foreshore access is constrained too frequently.

Ballina Pocket Beaches and South Ballina Beaches

The broad management objective adopted for these beach units is to allow coastal processes to proceed under monitoring.

Coastal erosion is generally expected to take the form of a gradual landward movement of the beach and dune system without a substantial change to the nature or extent of these environments, but resulting in a net loss of natural areas. The landward extent of erosion is likely to limited at Boulder and Shelley beaches due to the cobble fields that underlie the sand in these locations.

Monitoring by means of photogrammetric analysis is recommended in addition to dune management works where necessary, especially in critical locations such as the Flat Rock tombolo.

1 Introduction

1.1 Background

The coastline of the Ballina Shire is a dynamic environment subject to the natural processes of coastal erosion and accretion. An additional element of change is introduced by local developments, such as the Richmond River training walls and seawalls, and global phenomena, such as climate change and sea level rise, which alter the extent and nature of these processes to varying degrees.

This report, the Coastal Zone Management Plan for the Ballina Shire coastline (CZMP), represents the culmination of various studies and consultative processes. These studies and processes are described in the following:

- *Ballina Coastline Hazard Definition Study (WBM, 2003) and the Updated Coastal Hazard Areas for Ballina Shire: Stage 1 – Preliminary Update (BMT WBM, 2011) concentrating on Lennox Head;*
- *Ballina Coastline Management Study – Stage 1 Values Assessment (GeoLINK, 2007);* and
- *Ballina Coastline Management Study – Stage 2 Management Options Assessment (GeoLINK, 2008).*

This CZMP provides the strategic framework for Ballina Shire Council (Council) to protect coastal values in a manner that has the support of its government partners and the community.

1.2 Scope

1.2.1 Geographical scope

The geographical area covered by this CZMP includes the coastline of the Ballina Shire inland to the landward limit of coastal hazards over the 2100 planning period which are described in **Section 2.1** and, in the case of Lennox Head, shown in **Illustration 2.1** and **Illustration 2.2**.

1.2.2 Thematic scope

Subsection 55C(1) of the *Coastal Protection Act 1979* (CP Act) requires that a CZMP make provision for:

a) *protecting and preserving beach environments and beach amenity, and*

b) *emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event, and*

c) *ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion, and*

d) *where the plan relates to a part of the coastline, the management of risks arising from coastal hazards, and*

e) *where the plan relates to an estuary, the management of estuary health and any risks to the estuary arising from coastal hazards, and*

f) *the impacts from climate change on risks arising from coastal hazards and on estuary health, as appropriate, and*

g) *where the plan proposes the construction of coastal protection works (other than emergency coastal protection works) that are to be funded by the council or a private landowner or both, the proposed arrangements for the adequate maintenance of the works and for managing associated impacts of such works (such as changed or increased beach erosion elsewhere or a restriction of public access to beaches or headlands).*

Subsection 55C(3) permits the Minister to give direction that a CZMP make provision for only one or more of the items listed in subsection 55C(1). This CZMP does *not* relate to an estuary and thus does not provide for item (e) above.

Furthermore, the *Guidelines for Preparing Coastal Zone Management Plans* (DECCW, 2010) requires that a CZMP address three broad areas, namely:

- Managing risks to public safety and built assets;
- Pressures on coastal ecosystems; and
- Community uses of the coastal zone.

1.2.2.1 Managing risks to public safety and built assets

This CZMP focuses on maintaining or improving the ecological, cultural, recreational, and economic values that are exposed to the following coastal hazards:

- Beach erosion, due to offshore movement of sand from the sub-aerial beach during storms or an extreme or irregular event;
- Shoreline recession due to sediment budget deficits (i.e. more sand leaving a beach than entering it) and sea level rise; and
- Coastal inundation, resulting from extreme ocean storm events, overtopping dunes and inundating land behind the dunes.

The nature and extent of these coastal hazards are identified in WBM (2003) and BMT WBM (2011) and summarised in **Section 2.1**. The values and the respective threats posed by coastal hazards are outlined in GeoLINK (2007; 2008) and summarised **Section 2.2**.

1.2.2.2 Coastal Ecosystems and Community Uses of the Coastal Zone

Management of coastal ecosystems and community uses of the coastal zone has been thoroughly considered in various other plans including those listed in **Section 1.4**. In cases where ecological, cultural, recreational, and economic values are *not* exposed to coastal hazards this CZMP complements or refers to, without duplication, these plans, in particular the Ballina Coastal Reserves Plan of Management (CRPOM) and the Precinct Plans that underpin it.

In defining the purpose of the plan, the CRPOM states:

> *The primary objective of the Ballina Coastal Reserve Plan of Management is the rationalisation of all vacant Crown lands and existing Crown reserves into a single coastal Crown reserve for the notified purpose of Public Recreation and Coastal Environmental Protection with the appointment of Ballina Shire Council as Reserve Trust Manager.*
>
> *The [CRPOM] has been prepared by DLWC [now OEH] in partnership with Ballina Shire Council through Council's Coastal Committee. The Committee was established in 1999 primarily to oversee development of the Plan, and adopted as its terms of reference "……to assist Ballina Shire Council in achieving integrated, balanced, responsible and ecologically sustainable development of the Ballina Shire coast".*
>
> *...[The CRPOM] will consider social, economic, aesthetic, recreational and ecological values, wider aspects of land use in the coastal zone and an assessment of the impact of coastline hazards on future planning and land use.*

The CRPOM is described in more detail in **Section 1.4.1**.

1.3 Objectives

The *Guidelines for Preparing Coastal Zone Management Plans* (DECCW, 2010) sets out ten 'Coastal Management Principles' to guide the preparation and content of CZMPs, with Principle 1 as an overarching principle supported by the following nine principles. The principles and a description of how they are met in the CZMP are outlined in **Table 1.1** below.

Table 1.1 Coastal Management Principles presented in DECCW (2010) and how they are met by the CZMP

Coastal Management Principle		*CZMP measure to address principle*
Principle 1 Consider the objects of the *Coastal Protection Act 1979* and the goals, objectives and principles of the NSW Coastal Policy 1997 and the NSW Sea Level Rise Policy Statement 2009	**Principle 2** Optimise links between plans relating to the management of the coastal zone	▪ Ensure no overlap of CZMP with existing plans – refer Section 1.4
	Principle 3 Involve the community in decision-making and make coastal information publicly available	▪ Extensive community consultation conducted – refer Section 1.5
	Principle 4 Base decisions on the best available information and reasonable practice; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach	▪ Based on adopted Coastal Hazard Definition Study (WBM, 2003) ▪ Formal peer review of WBM (2003) and technical stakeholder meeting of 18 October 2010 ▪ Revision of recession hazard areas for Lennox Head (BMT WBM, 2011) ▪ Ongoing monitoring program to refine hazard estimates and direct management actions
	Principle 5 The priority for public expenditure is public benefit; public expenditure should cost-effectively achieve the best practical long-term outcomes	▪ GeoLINK (2006) identified a wide range of values ascribed by the public to the Ballina coastline, including: – Ecological values; – Cultural heritage and social values; – Landscape and visual amenity values; – Recreational and tourism values; and – Economic values. ▪ GeoLINK (2007) considered how coastal hazards may threaten these values and identified a wide range of possible management measures, including: – Planned retreat; – Beach nourishment; – Seawalls (with and without beach nourishment); – Groynes (with and without beach nourishment); and – Dune management works, such as vegetation, 4WD and pedestrian access, stormwater outlets, and dune strengthening by sand capture fencing.
	Principle 6 Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risks where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented	▪ High, medium and low risk areas identified – refer GeoLINK (2007) ▪ Risk avoidance (planned retreat) considered ▪ Low-cost short-term management actions (dune management) recommended as interim measure ▪ Assessment of level of current mitigation from existing protective structures to direct nature and extent of subsequent works

Coastal Management Principle	CZMP measure to address principle
Principle 7 Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions	▪ Detailed investigation of existing mitigating structure (buried seawall) in high risk area (Byron Street to Lake Ainsworth Sport and Recreation Centre, Lennox Head) to determine nature and extent of mitigating influence ▪ Staged implementation of management measures for high risk area ▪ Formal trigger points established for high-cost long-term management actions
Principle 8 Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems	▪ Protect Littoral Rainforest EEC at Boulder Beach ▪ No *high value* coastal ecosystems under immediate threat
Principle 9 Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy	▪ Adoption of and reference to Precinct Plans that make full consideration of on-going management of beach access points.
Principle 10 Support recreational activities consistent with the goals of the NSW Coastal Policy	▪ Recreational values identified in GeoLINK (2006) and management of associated coastal hazard threats considered in GeoLINK (2007). Management response in CZMP developed accordingly.

1.4 Existing Management Plans, Studies and Planning Instruments

There are a large number of existing studies, management plans and planning instruments that have varying degrees of interrelation and relevance to the scope and objectives of the CZMP. The preparation of this CZMP has taken into account the findings, recommendations and requirements set out in these various documents.

The existing studies and management plans and studies that relate to areas potentially under coastal hazard threat include:

- Ballina Flood Study Update (BMT WBM, ongoing)
- Richmond River Estuary Processes Study (WBM, 2006) and Study Review (ABER, 2007);
- Coastal Zone Management Plan for the Richmond River Estuary (Hydrosphere, 2011) ;
- Richmond River Nature Reserve Plan of Management (DEC, 2005);
- Ballina Nature Reserve Plan of Management (DEC, 2003);
- Ballina Coastal Reserve Plan of Management (BSC and DLWC, 2003b);
- Ballina Shire Council Social Plan (BSC, 2004);
- Community Based Heritage Study (BSC, in prep.);
- Threatened Species (Pied Oystercatcher) Management Strategy (DoL, 2006);
- The Coastal Reserve Precinct Plans (BSC, 2004 a to e);
- Lake Ainsworth Management Plan (GeoLINK, 2001);
- Lake Ainsworth Crown Reserve Master Plan (Connell Wagner and Hassell, 2005);
- Shaws Bay Estuary Management Plan (BSC, 2000);
- Ballina Coastline Interim Measures and Action Plan (BSC, 2005);
- Ballina Strategic Tourism Plan (Fletcher and Associates and the North Coast Ad Agency, 2002);
- Lennox Headland Master Plan (GeoLINK, 2007); and
- Ballina Shire Coastal Vegetation Management Plans (EnviTE, var. dates).

The planning instruments that relate to areas potentially under coastal hazard threat include:

- Ballina Local Environment Plan 1987;
- Lennox Head Community Aspirations Strategic Plan 2002;
- Lennox Head Structure Plan 2004;
- Lennox Head Beach Management Plan 1993;
- Ballina Combined Development Control Plan – Chapter 3 Coastal Hazard Protection Lennox Head;
- Ballina Combined Development Control Plan – Chapter 8 Lennox Head Village; and
- Ballina Combined Development Control Plan – Chapter 17 Coastal Hazard Protection, Lennox Head (Interim Measures)

1.4.1 Ballina Coastal Reserve Plan of Management and Precinct Plans

Council's management approach and specific actions for coastal ecosystem health and community uses of the coastal zone are outlined in significant detail in Ballina Coastal Reserve Plan of Management (CRPOM) and the associated Precinct Plans that underpin it.

The CRPOM was developed in order to rationalise all vacant coastal Crown lands and existing Crown reserves into a single coastal Crown reserve. It was prepared internally by Council, supported and informed by extensive community consultation, and was adopted in 2003.

The single coastal Crown reserve is for the purpose of public recreation and coastal environmental protection with the appointment of Ballina Shire Council as Reserve Trust Manager.

Underpinning the CRPOM are five precinct plans that set out locally specific management actions to meet the broad objectives and strategies outlined in the CRPOM. The five precincts are:

- Precinct area 1 – Northern end of Seven Mile Beach
- Precinct area 2 – Southern end of Seven Mile Beach (Lake Ainsworth to Lennox Point)
- Precinct area 3 – Boulder Beach to Sharps Beach
- Precinct area 4 – Flat Rock, Angels Beach and Black Head
- Precinct area 5 – Shelly Beach & Lighthouse Beach

The actions set out in the Precinct Plans include consideration of:

- Dogs
- Horses
- Beach access for vehicles
- Camping and social functions
- Commercial activities
- Dune stabilisation
- Vegetation management
- Other land managers
- Aboriginal heritage
- European heritage
- Surf Life Saving Clubs
- Traffic and parking
- Stormwater
- Pedestrian access
- Beach and headland erosion
- Public amenities
- Walkways and cycleways
- Development
- Water quality
- General regulations
- Education

The actions within the precinct plans are comprehensive, have been developed on the basis of extensive community consultation, and have been adopted by Council. This CZMP is required to fully integrate the objectives, recommendations and actions of CRPOM, both as a Council requirement and a requirement under Section 55c of the *NSW Coastal Protection Act 1979*. Under direction of Council, in order to avoid the duplication of previous processes or established outcomes, this CZMP wholly adopts the objectives, recommendations and actions of the CRPOM and the precinct plans, and makes reference to the precinct plan actions where necessary.

1.4.1.1 Consideration of Coastal Hazards in the Ballina Coastal Reserve Plan of Management and Precinct Plans

The CRPOM outlines a number of broad management objectives and the strategies by which those objectives will be met. With respect to coastal erosion, the CRPOM management objective is:

> "Give the impacts of natural hazards a high priority in the planning and management of the Coastal Reserve."

To address this objective, the CRPOM refers directly to WBM (2003), and by inference this CZMP, without further detail or direct reference to the coastal hazard mitigation influence of management strategies. Nevertheless, a number of the management strategies presented in the CRPOM and associated Precinct Plans will assist in the mitigation of coastal hazard, and cross references to these strategies are provided in the CZMP.

1.4.2 The coastline south of the Richmond River

The coastline south of the Richmond River is primarily managed by

- The Crown Lands Division of the NSW Department of Trade and Investment, Regional Infrastructure and Services; and
- The National Parks Wildlife Service of the Office of Environment and Heritage within the NSW Department of Premier and Cabinet.

However Ballina Shire Council has responsibility for 1.4 Ha parcel of land adjacent to the settlement of Patches Beach. For this parcel, Council has prepared a vegetation management plan which addresses a variety of issues including damage to dunes, weed infestation, erosion and predation by feral animals.

The Threatened Species (Pied Oystercatcher) Management Strategy (Department of Lands, 2007) aims to facilitate cooperative land management to minimise the impact of human activities on the Pied Oystercatcher within the area bounded by the southern breakwall of the Richmond River and the Black Rocks 4WD access track which is beyond the Ballina LGA boundary.

1.5 Stakeholder Consultation

The preparation of the study and plan has been underpinned by regular consultation with the project Community Reference Group (established specifically for this project), the Ballina Shire Council Civil Committee, the Office of Environment and Heritage, and the general public. Key steps have also been reported to open meetings of the elected Council.

1.5.1 Community Reference Group

The primary consultative mechanism for this study is the Community Reference Group convened by Ballina Shire Council. The group's members were chosen by Council and assigned to the project as experienced and informed representatives of sections of the community and government agencies. The Community Reference Group operates under Terms of Reference which are included in **Appendix C**.

The Community Reference Group includes representatives of the following groups:

- Office of Environment and Heritage;
- Department of Lands;
- Lennox Head Residents Association;
- Ballina Environment Society;
- Lennox Head Landcare;
- Ballina Chamber of Commerce and Industry;
- Cape Byron Marine Park;
- Ballina Shire State Emergency Service;
- East Ballina Landcare; and
- Jali Local Aboriginal Land Council.

The Community Reference Group has met on four occasions to consider the study and plan:

- 26 August 2006 – introduction to project, review of Ballina Coastline Hazard Definition Study, responsibilities of group
- 14 November 2006 – identification of coastline values, study context
- 15 May 2007 – review and confirmation of values, consideration of management options and assessment criteria
- 14 August 2007 – assessment of management options for key locations, identification of preferred options

1.5.2 Ballina Shire Council Civil Committee

The Ballina Shire Council Civil Committee comprises all Ballina Shire Councillors and staff designated by the General Manager. The primary function of the committee is policy formulation; however it often meets to consider items in detail prior to submission of the matter to the Council. It has no delegated authority and meeting minutes and recommendations are submitted to Council for approval.

The committee has met on three occasions to consider the study and plan:

- 29 October 2007 – review of management options and their consequences, preliminary recommendations on preferred options
- 14 March 2008 – review of Ballina Coastline Management Study
- 9 July 2008 – review of public comments on study, confirmation of recommendations

1.5.3 NSW Office of Environment and Heritage

The NSW Office of Environment and Heritage (OEH) is the division of the NSW Department of Premier and Cabinet that is the lead agency in implementing government policies, guidelines and legislation in relation to coastal zone management. OEH also administers the NSW Government's Coastal Management and Estuary Management programs which are the primary mechanism for assisting local councils in the preparation and implementation of Coastal Zone Management Studies and Plans. Representatives of OEH have reviewed this CZMP and the preceding management studies (GeoLINK, 2007; GeoLINK, 2008) at critical stages, and have been closely consulted on key elements.

1.5.4 Natural Disaster Mitigation Program

The Natural Disaster Mitigation Program (NDMP) is a national program aimed at identifying and addressing natural disaster risk priorities across the nation. The Ballina Coastline Management Study and this CZMP are jointly funded by Ballina Shire Council and the NDMP. Progress reporting to NDMP managers has continued throughout the project.

1.5.5 Public Consultation

Throughout the preparation of the study and the plan, the project team has remained open to receiving comments from the public as highlighted in all promotional material. The public has been informed of opportunities to comment by the shire-wide circulation of flyers in the Ballina Shire Advocate newspaper at key stages of the project. Flyers were circulated on the following dates:

- 24 August 2006 – general introduction to project
- 9 November 2006 – identification of coastline values (advertised 18 November 2006 open day)
- 29 May 2008 – review of recommended management options (advertised public exhibition of study and 14 June 2008 public open day)

Copies of these flyers are included in **Appendix D**.

Key members of the project team made themselves available to discuss the project with the public by means of open days whereby project material was placed on display boards in a prominent location. The public open days were held on the following dates:

- 18 November 2006 (River Street, Ballina) – identification of coastline values
- 25 August 2007 (Lennox Head shops) – Ballina coastal hazards and the range of possible management options
- 14 June 2008 (Lennox Head shops) – review of the study and recommended management options (held during public exhibition period)

1.5.5.1 Public submissions

Throughout the course of the preparation of the study and plan, 25 formal submissions were received, two of them major submissions of more than 10 pages. Of these 25 submissions, only one referred directly to management of coastal hazards, in particular suggesting that the stormwater discharges across Seven Mile Beach weaken the natural protective capacity of the dunes. The remainder, excluding the two major submissions, focussed primarily on the provision of facilities, beach access and vegetation management – all of which are considered in detail in the Ballina Coastal Reserve Plan of Management and the associated precinct plans.

The two major submissions were primarily concerned with challenging the hazard estimates put forward in WBM (2003) which was reviewed by the NSW Government and adopted by Council in 2003. The nature and complexity of estimating coastal hazard is discussed briefly in **Section 2.1.2**.

2 Summary of Coastal Hazards and Coastal Values

2.1 Coastline Erosion Estimates

The Ballina Shire Coastline Hazard Definition Study (WBM, 2003) and the Updated Coastal Hazard Areas [for Lennox Head] (BMT WBM, 2011) provide a detailed understanding of the physical coastal and ocean processes and associated coastal erosion mechanisms. They are collectively referred to here as the CHDS.

Generally, the CHDS found that these coastal and ocean processes are highly dynamic, change in response to the prevailing conditions, and are influenced by human action (e.g. Richmond River training walls, climate change, seawalls).

The CHDS provided estimates of the potential extent of future erosion associated with the following coastal hazards:

- Beach erosion, due to offshore movement of sand from the sub-aerial beach during storms or an extreme or irregular event;
- Shoreline recession due to sediment budget deficits (i.e. more sand leaving a beach and its embayment than entering it), and sea level rise; and
- Coastal inundation, due to large waves, resulting from extreme ocean storm events, overtopping dunes or seawalls and inundating the land behind.

These erosion mechanisms typically occur together with total recession distance an additive combination of these estimates. Historical shoreline movements include the influences of these naturally varying processes as well as the impacts of human activities/works. For planning purposes, the CHDS identified potential erosion hazard bands for immediate (beach erosion), 2050, and 2100 planning periods. The erosion estimates presented in the CHDS assume no management intervention and, at Lennox Head north of Byron Street no mitigating influence of the existing buried seawall or other existing structures (see **Section 3.4.1**).

In recognition of the natural variability and considerable uncertainties associated with natural and anthropogenic influences, and their combination, on coastal erosion mechanisms, a range of long term recession rates and resulting hazard bands were determined with the intent of providing sufficient information for consideration of the threats in future planning.

The CHDS also recognised that there are uncertainties associated with the structural capacity of the buried seawall at Lennox Head and how effective this may be in limiting shoreline recession. Again to assist future planning and provide information on the potential upper limit of erosion in the absence of any protection measures, hazard zones were assessed excluding any mitigating effects of this wall.

Table 2.1 below summarises the coastal erosion estimates for the beach units of the Ballina coastline. **Illustration 2.1** and **Illustration 2.2** show the erosion hazard bands for the Lennox Head beach units. Note that the table and illustrations must be considered within the context of the CHDS, particularly Sections 6.7.3, 7.1 and 7.2 of WBM (2003) and Section 2 of BMT WBM (2011) which outline the basis for their development and the uncertainty associated with estimates of coastal hazard.
As stated in the CHDS and discussed in **Section 2.1.2**, there is uncertainty around the recession distances shown in **Table 2.1** and **Illustration 2.1** and **Illustration 2.2**. This is reflected in the ranges that are given for the recession associated with beach erosion and sediment budget deficit. No range is provided for the recession associated with sea level rise as this is based on a simple application of the Bruun Rule using the vertical sea level rises put forward in the *NSW Seal Level Rise Policy Statement* (DECCW, 2009). (See Section 4.10.3 of WBM (2003) for a general explanation of the Bruun Rule.)

It should be noted that recently revised sea level rise estimates (refer to **Section 2.1.1**) increase the risk that some public assets at the southern end of Shelly Beach may be exposed to coastal hazard by 2100. However, in the absence of a formal study, the level of this risk cannot be confirmed.

2.1.1 Revision of Coastal Hazard Lines for Lennox Head

BMT WBM (2011) provided an update of hazard lines presented in WBM (2003) for the critical area of Seven Mile Beach adjacent to the township of Lennox Head. This revision comprised:

- Definition of existing beach conditions using the most recent available photogrammetry (January 2010);
- Reassessment of the current (immediate) hazard line based on the most recent photogrammetry and an assumed design beach erosion volume of 200 m³/m; and
- Revision of long term shoreline recession estimates accounting for updated projected climate change related sea level rise allowances as presented in the *NSW Sea Level Rise Policy Statement* (DECCW, 2009).

The WBM (2011) revision found that the beach in this area had accreted since the assessments presented in WBM (2003). Both analyses adopted of the same assumed design beach erosion volume of 200 m³/m). The result was that the current (immediate) hazard line presented in BMT WBM (2011) is approximately 20 m seaward of that presented in WBM (2003).

The sea level rise allowances presented in the *NSW Sea Level Rise Policy Statement* (DECCW, 2009) were adopted in BMT WBM (2011). These allowances were 40 cm by 2050 and 91 cm by 2100 above 1990 levels, and an interim rate of sea level rise of 3 mm/yr since 1990. WBM (2003), based on the best available advice at the time, adopted sea level rise allowances of 20 cm by 2050 and 50 cm by 2100. Both analyses applied the Bruun Rule in the same fashion with the only difference being the sea level rise allowances. (See Section 4.10.3 of WBM (2003) for a general explanation of the Bruun Rule.) The result was that the 2050 hazard line presented in BMT WBM (2011) is approximately 10 m seaward of that presented in WBM (2003) and the 2100 hazard line is approximately in the same location as that presented in WBM (2003).

Table 2.1 Erosion Recession Estimates due to Coastal Hazards (based on WBM (2003) and BMT WBM (2011))

Beach Unit	Time frame	Beach erosion [7]	Shoreline recession			
			Sediment budget deficit			Sea Level Rise [8]
			Lower estimate	Best estimate	Upper estimate	
North Seven Mile [1]	2050	Not estimated (25-40 m)	10 m	15 m	22.5 m	20 m
	2100	Not estimated (25-40 m)	20 m	30 m	45 m	45 m
Central Seven Mile [1]	2050	Not estimated (25-40 m)	15 m	25 m	35 m	20 m
	2100	Not estimated (25-40 m)	30 m	50 m	70 m	45 m
Lennox Head (north of Byron St) [2]	2050	40-45m	15 m	25 m	35 m	20 m
	2100	40-45m	30 m	50 m	70 m	45 m
Lennox Head (south of Byron St)	Erosion is expected to be limited by two sections of rock revetment sea wall and a constructed levee as shown in **Illustration 3.2**. See Section 5.3.1 of GeoLINK (2008) for further discussion.					
Boulder Beach [3]	2050	Not estimated (25-40 m)	5 m	10 m	15 m	20 m
	2100	Not estimated (25-40 m)	10m	20 m	30 m	45 m
Ballina Pocket Beaches [4]	2050	Not estimated (25-40 m)	-	10m	-	20 m
	2100	Not estimated (25-40 m)	-	10m	-	45 m
South Ballina Beaches [5]	2050	30 m	0 m	2.5 m	5 m	20 m
	2100	30 m	0 m	5 m	10 m	45 m
Patches Beach [6]	2050	20-30 m	5 m	10 m	15 m	20 m
	2100	20-30 m	10 m	20 m	30 m	45 m

[1] WBM (2003) Sections 8.5.2 and 8.5.3. Note that shoreline recession estimates reduce by 33% at the northern limit of North Seven Mile beach (the shire boundary)

[2] BMT WBM (2011) and WBM (2003) Section 8.4.2 and 8.4.3. Note WBM (2003) also suggests that the cobbles that dominate this beach unit are likely to limit the extent of erosion, however no estimate of this limiting effect is p

[3] WBM (2003) Section 8.4.2 and 8.4.3. Note WBM (2003) also suggests that the cobbles that dominate this beach unit are likely to limit the extent of erosion, however no estimate of this limiting effect is presented.

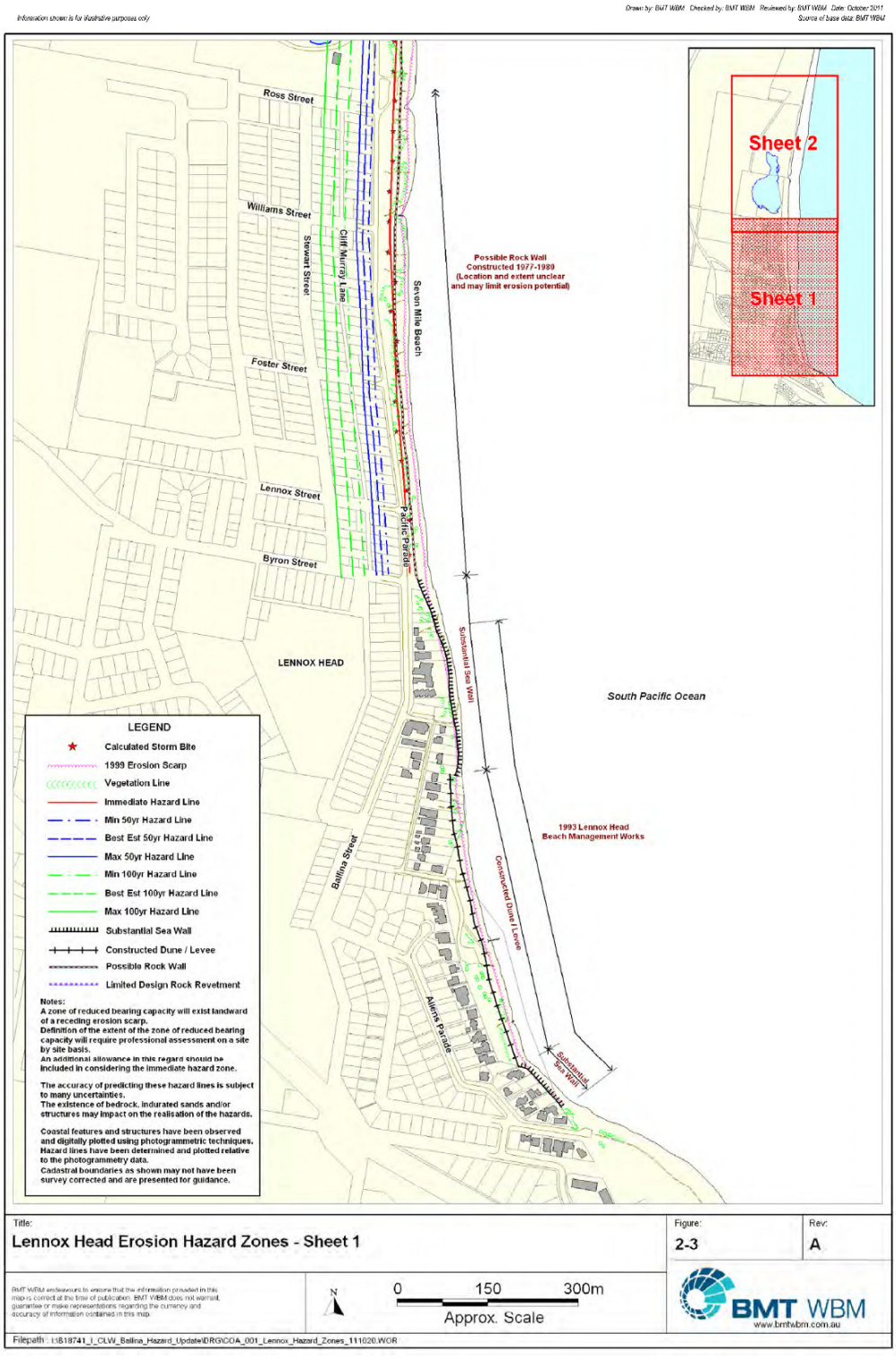
[4] The Ballina Pocket Beaches are Boulder Beach (considered separately here), Sharpes Beach, Angels Beach, Shelly Beach and Lighthouse Beach

[5] WBM (2003) Section 8.3.2 and 8.3.3

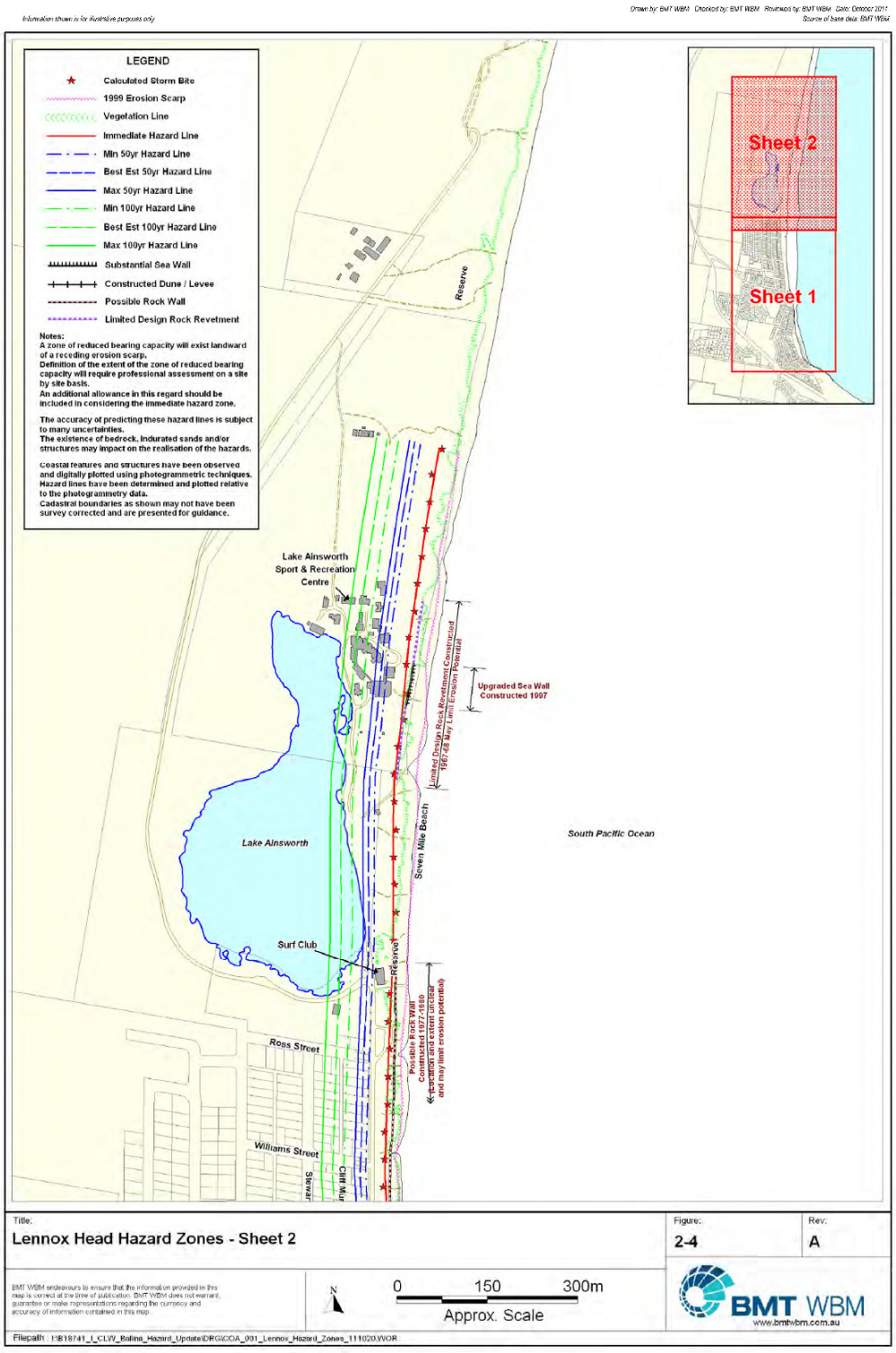
[6] WBM (2003) Section 8.2.2 and 8.2.3

[7] WBM (2003) does not provide lateral distances for beach erosion for some beach units. Instead, it recommends the adoption of a loss of 200 m^3 of beach and foredune sand above MSL per lineal metre of coastline (in line with estimates for other Ballina beaches). This corresponds to around 25-40m of lateral recession and depends on dune height and, in the cases of Boulder and Sharpes beaches, the mitigating effect of cobbles. BMT WBM (2011) adopts the 200 m^3/m rate for Lennox Head north of Byron Street.

[8] Lateral recession distances associated with sea level rise estimates have been derived using the standard approach employing the Bruun Rule. The Bruun Rule is discussed in Section 4.10.3 of the CHDS. The figures in parentheses are the 2100 lateral recession distances based on the sea level rise estimates required by DECCW (2009) (refer Section 0) and revised under BMT WBM (2011)



Lennox Head Erosion Hazard Zones - Sheet 1 (from BMT WBM, 2011)



Lennox Head Erosion Hazard Zones - Sheet 1 (from BMT WBM, 2011)

GeoLINK BMT WBM 0786640 Coastal Zone Management Plan for the Ballina Shire Coastline Illustration 2.1

2.1.2 Uncertainty in Coastal Erosion Estimates

The determination of coastal erosion resulting from beach erosion (due to storms or an extreme or irregular event), and shoreline recession (due to sediment budget deficits and sea level rise) will always be subject to debate and review and estimates will change as new information comes to hand, particularly with an increasing base of historical data.

The complexities and deficiencies in the understanding of the coastal processes occurring in the Ballina LGA are highlighted in WBM (2003). The CHDS estimated each of the components of the erosion hazard on the basis of the data and information available at the time. With respect to Lennox Head and Seven Mile Beach, the range of factors that are likely to be influencing the past and future behaviour and the uncertainties involved are discussed in Section 6.7.3 of WBM (2003). The report goes on to acknowledge that there is not yet a comprehensive understanding of all of the factors influencing coastal erosion. However, in the absence of investigations beyond the scope of the CHDS, estimation of coastal erosion relied predominantly on the photogrammetric data covering the period 1947 to 1999 for WBM (2003), which was augmented with photogrammetric data from 2010 in BMT WBM (2011).

Section 7.1 of WBM (2003) notes that the influences of man-made structures, such as protective seawalls and river entrance training walls, disguise the underlying *natural* recession rate. This makes the interpretation of the erosion hazard components from the data difficult in some areas. However, the underlying effect of these structures in altering the coastal alignment is largely inherent in the photogrammetric analysis. Interpretation of these effects was bolstered by the knowledge gained from previous studies (for example impacts of the Tweed River training walls on Gold Coast beaches).

Furthermore, Section 7.5 of WBM (2003) notes progressive long term hazard typically does not occur at a consistent rate every year and it can be expected that there will be periods of higher and lower erosion and recovery within a longer term pattern of change. This is evident in the historical photogrammetry record which shows that the behaviour over the last 50 years incorporates both periods of extensive erosion and subsequent recovery due to both natural and anthropogenic influences.

The findings of the CHDS rely on interpretation by its authors of the available data. It clearly advises that, while the assessed hazard components represent the best estimate at the time within the limitations of available data, the hazard definition work should be viewed as an advisory tool only in the formulation of long term management strategies. The hazard zones remain open to review on the basis of ongoing investigation and monitoring. The implicit uncertainties and limitations of the predictive capabilities are reflected in recommended management actions, with a long-term management strategy that is both robust and flexible in order to accommodate future changes in coastal process regimes. While somewhat different interpretive approaches to identifying the persisting long term trends could be adopted in areas directly impacted by adjacent works, the coastline management provisions will accommodate such differences.

Section 8.5.3 of WBM (2003) clearly acknowledges that the shoreline recession along Lennox Head and Seven Mile Beach has been influenced by a reduced supply of sand from the south in the past, with such influences likely to be reducing over time, and that the seawall works at Lennox Head are likely to have exacerbated the erosion further north.

At the 2009 NSW Coastal Conference, Dean Patterson of BMT WBM presented the findings of recent modelling of the sand transport along the Ballina coastline, with a particular emphasis on investigating the influence of the Richmond River training walls that were built between 1890 and 1910. The findings presented in the paper include the following.

- *The training walls appear to be the dominant influence on the sustained shoreline erosion that has been experienced at Lennox Head and Seven Mile Beach.*
- *In the absence of sea level rise, the shoreline appears to be recovering slightly at south Lennox Head and has stabilized along Seven Mile Beach. Ongoing monitoring is needed to confirm this.*

- *Despite the above, there appears to have been a long term reduction in the longshore transport past the training walls and along Seven Mile Beach and some impact of the training walls may start to be felt at Suffolk Park [north of Ballina Shire] over the next 100 years.*
- *Sea level rise will exacerbate the erosion at all beaches in a manner that is more complex than that indicated by application of the 'Bruun Rule', with headland controls minimizing recession updrift and exacerbating recession (up to 2-3 times) downdrift of those controls. This is a significant issue for future management considerations. Note that the modelled behaviour at Lennox Head does not include the control on recession provided by the seawalls constructed there.*

(Patterson, 2009)

These findings suggest that there may be cause to see the recession rates developed in the CHDS as potential overestimates for a long term trend as they may have been artificially and temporarily accelerated by the training walls.

However, the final finding listed above suggests that the recessional effect per unit of sea level rise on the southern parts of Seven Mile Beach (which is downdrift of the Lennox Headland control), considerable proportion of the total shoreline recession, may have been underestimated "up to 2-3 times" in the CHDS by use of the Bruun Rule. It should be noted that in the absence of complex modelling, application of the Bruun Rule is common practice.

Given the uncertainty as to the balance of all of these effects, a cautionary approach was adopted for long term planning purposes with recession rates based primarily on historical trends with due regard to these anthropogenic influences. It is acknowledged that the erosion hazard lines presented in BMT WBM (2011) for the section of beach between Byron Street and Lake Ainsworth are in the area of greatest uncertainty as to what may have occurred there without anthropogenic interference in natural processes.

In response to this uncertainty, the CZMP recommends ongoing monitoring of the progressive pattern of beach/dune behaviour and investigation of the feasibility of the 'soft' option of beach nourishment as an integral first step, with any subsequent works or other action dependent on monitoring and investigations. In the absence of sufficient resources for a comprehensive regional process-based investigation of the long term behaviour of this coastal system, proposed ongoing site-based monitoring and continued utilisation of historical photogrammetry, represent the most responsible and cost-effective means of providing a basis for ongoing coastline management in the area.

2.2 Coastline Values and Threats

Many ecological, cultural, social, recreational and economic values are ascribed to the Ballina coastline by the community. Some of these values are considered to be under coastal erosion threat. These values and threats are reviewed in detail in stages one and two of the *Ballina Coastline Management Study* (GeoLINK, 2007; GeoLINK, 2008), and are summarised here.

2.2.1 Ecological values

Vegetation clearance, agricultural practices and flood mitigation works have altered the ecology of the coastal zone of Ballina; however it still holds rich and diverse ecological values.

Ecological values of marine environments include:

- sandy beaches that support simple invertebrate communities, shorebirds and sea birds;
- rocky shores that support more complex invertebrate communities, as well as more complex terrestrial communities including birds, reptiles, insects, invertebrates and small-medium mammals;
- off-shore reefs that support a range of threatened fish, as well as two turtle species; and
- sub-tidal sand that supports invertebrates and fish, and a number of species of commercial importance

- habitats that support over 65 species of conservation significance, and include the southern extent of the Cape Byron Marine Park.

Ecological values of terrestrial and estuarine environments include:

- seagrass that support highly productive nursery and feeding grounds for a diversity of aquatic species;
- mangroves and saltmarsh that support highly productive nursery and feeding grounds for a diversity of aquatic species, and provide important habitat for many bird and terrestrial species;
- freshwater wetlands that support numerous Endangered Ecological Communities under the NSW Threatened Species Conservation Act and provide habitat for numerous threatened fauna species;
- communities on coastal sands that support a high diversity of threatened fauna species restricted to these habitat types; and
- a freshwater coastal lake, Lake Ainsworth, which supports an unusual diversity of habitats, and a unique suite of species.

Terrestrial and estuarine environments in Ballina Shire support eight flora species of conservation significance, and include the southern extent of the Cape Byron Marine Park.

2.2.1.1 Coastal erosion threats to ecological values

The complexity of ecosystems and uncertainty inherent in estimating coastal erosion means it is impossible to determine with great detail the nature and extent of coastal erosion threats to many ecological values.

Estimated recession distances summarised in **Table 2.1** can be translated simplistically into spatial extents of natural environments that may be lost as a result of recession due to coastal erosion, as shown in **Table 2.2**. Under this simplified approach, recession processes on open stretches of coast are expected to shift dunal systems landward without significant alteration to their structure, shifting the losses of natural area to the environments found landward of the dunes. These natural areas, generally coastal heath, are often extensive in relation to the area that is estimated to be lost as a result of recession.

The hazard estimates presented in the CHDS suggest that oceanic breakthrough of Lake Ainsworth is quite possible (although the protective effect of the buried seawall seaward of the lake has not been included due to uncertainty). Even a temporary breakthrough would result in a significant ecological shift in the existing freshwater lake system, and a subsequent loss of much of its current unique and high ecological value. Sustained breakthrough of the dunal system seaward of the lake is likely to result in permanent loss of the lake and a major localised realignment of Seven Mile Beach.

It is recognised that sandy beaches support large and diverse communities of infauna and interact physically with inshore marine areas. Coastal erosion estimates suggest that the sandy beach at Lennox Head, and possibly Boulder Beach, may be lost 'against' hard structures (or in the case of Boulder Beach, the natural cobbles) as recession proceeds landward. Loss of the beach's infaunal community may have effects on inshore food webs, and prolonged absences of sand will likely alter local inshore rocky reef ecosystems.

The sea level rises above 1990 levels put forward in DECCW (2009) (40 cm by 2050 and 90 cm by 2100) constitute significant proportions of the local tidal range. Intertidal rock platforms without a substantial vertical range, such as Flat Rock, are likely to undergo significant ecological shifts as a result of alterations to the periods of inundation and exposure due to such changes in mean sea level.

2.2.2 Cultural heritage values

The Ballina area, believed to have supported one of the densest Aboriginal populations in Australia, has enormous Aboriginal cultural significance, although much of it remains formally undiscovered.

There are 76 registered Aboriginal sites in the Coastal Zone of Ballina. The vast majority of these are shell middens (37) and stone artefact scatters / open campsites (32). Five burial sites, one bora / ceremonial site and one stone quarry have also been registered. Only one of these sites, a midden (OEH reference number 4-5-184) is located close to the landward extent of the 2100 hazard line. While the extent of future damage is uncertain, it is unlikely that this site can be preserved in-situ.

The study area contains 23 significant European historic cultural heritage items listed on heritage registers. In addition to these registered heritage items, two tea tree fences on Seven Mile Beach should be noted as unique coastal items of European heritage in the shire. These may be lost as a result of coastal erosion. The Australian Historic Shipwreck Database lists 29 entries for the Coastal Zone of Ballina.

2.2.2.1 Coastal erosion threats to cultural heritage values

Two registered Aboriginal sites (an artefact scatter and a midden) are seaward of the 2100 hazard line presented in the CHDS and three sites (a burial, an artefact scatter and a midden) are seaward of the 50-year coastal erosion hazard line. All sites are therefore expected to be lost within the relevant timeframe. The burial site is reported to be below the existing seawall seaward of Rayner Lane in Lennox Head.

The tea tree fences on Seven Mile Beach, unregistered European heritage items, are seaward of the immediate hazard line and therefore may be lost in the next extreme storm event. No registered items of European heritage are seaward of the erosion estimates.

Table 2.2 Estimates of public land lost due to coastal recession for each beach unit

Beach Unit	*Land type lost*	*Length (m)*	*Estimated shoreline recession 2050[a] (m)*	*Area lost 2050 (m^2)*	*Estimated shoreline recession 2100[a] (m)*	*Area lost 2100 (m^2)*
North Seven Mile Beach	Coastal heath	1,250	35	43,750	75	93,750
Central Seven Mile Beach	Coastal heath	2,350	45	105,750	95	223,250
Lennox Head – North of Byron Street	Coastal heath (limit of 50 m width assumed seaward of LASRC [b])	950	45	42,750	50 (limit)	47,500
	Urban Parkland (limit of 25m width assumed seaward of Pacific Pde [b])	850	25 (limit)	21,250	25 (limit)	21,250
Lennox Head – South of Byron Street	Beach loss against seawall/levee (limit of 25m beach width assumed)	950	25 (limit)	23,750	25 (limit)	23,750
Boulder Beach [b]	Coastal heath	400	30	12,000	65	26,000
Sharpes Beach [c]	Coastal heath	1,000	30	30,000	55	55,000
Angles Beach [c]	Coastal heath	1,400	30	42,000	55	77,000
Shelly Beach	Coastal heath	600	30	18,000	55	33,000
Lighthouse Beach	Coastal heath	620	30	18,600	55	34,100
South Ballina, Beswicks, Robins and Patchs beaches	Coastal heath	17,200	26	447,200	58	997,600
	Coastal heath (m^2)			760,050		1,587,200
	Urban parkland (m^2)			21,250		21,250
	Beach (m^2)			23,750		23,750
	TOTAL (m^2)			**547,350**		**1,632,200**

[a] Landward shoreline movement comprises long term shoreline recession based on WBM (2003) and BMT WBM (2011) and lateral recession due to sea level rise based on DECCW (2009) and BMT WBM (2011). Figures adopted from **Table 2.1** using "best estimate" for long term shoreline recession distance. See **Section 2.1** for further discussion.

[b] Refer **Section 2.2.4.1** for consideration of built assets such as LASRC and Pacific Parade.

[c] The cobbles that dominate this beach unit are expected to limit coastal erosion, however this has not been quantified and the erosion rates presented in the CHDS are adopted

[d] These estimates do not consider the losses that may occur as a result of detachment of the Flat Rock tombolo

2.2.3 Social and recreational values

Census data shows that in 2001 the shire population was 37,218, increasing by approximately 503 people annually, or 1.4%, between 1996 and 2001. Around 63% of the shire population lives on the 'coastal fringe' (BSC, 2006), primarily comprising the coastal settlements of Ballina, Skennars Head and Lennox Head.

During the December-January peak holiday period it is estimated that over 29,000 overnight visitors spend time in Ballina Shire. On average, over 11,000 overnight visitors spend time in Ballina Shire every month.

The coastline is undoubtedly one of the key recreational attractions of Ballina Shire. The report *Facts and Figures Ballina Shire* (BSC, 2003) states:

> 'Water based recreation activities such as fishing, surfing, and boating are…major tourist attractions and feature among the favoured pastimes of Ballina Shire residents.'

Among tourists 'visiting the beach' was the most popular single activity, with 44% of international visitors and 24% of domestic visitors reporting this as their primary reason for visiting the shire (BSC, 2003).

In February 2009 the Lennox Head National Surfing Reserve was declared to formally recognise the environmental, cultural and historical significance of the reserve area to Australian surfing culture. The reserve area stretches from the south side of Flat Rock to the Lennox Head SLSC at the northern end of Lennox Head village, and extends 500 m seaward of the high water mark. The reserve does not alter any existing laws or licences.

2.2.3.1 Coastal erosion threats to social and recreational values

Coastal erosion, and the alterations it is expected to bring to the coastal environment, are not likely to *threaten* social values, but are certain to bring general concern and political tension. Similarly, general recreational values will not be eliminated but are likely to be stressed as a result of a reduction in the area of coastal environments available for passive and active recreation. Some specific local recreation values may be lost such as those ascribed to the beach at Lennox Head (proximity to the village, ambiance) which is expected to be lost 'against' the existing seawall and constructed levee.

2.2.4 Economic Values

Elements that contribute to the local economic value of the Ballina Shire coastline include:

- tourism;
- agriculture;
- commercial and recreational fishing;
- recreation;
- private and community assets; and
- public lands.

Around 57% of overnight visitors and 28% of day visitors report that visiting the beach and fishing are their primary reason for visiting Ballina Shire. Overnight visitors and day visitors are estimated to spend respectively $107M and $33M annually within Ballina Shire. Assuming a producer surplus of 20%, ascribing the proportions of visitors whose primary reason for visiting is an activity in the coastal zone, and considering the flow-on spending on other non-coastal activities suggests that the Ballina coast is worth around $18M annually to the local economy. (These calculations, and their basis, are outlined in more detail in GeoLINK, 2007).

This activity-based estimate accords with estimates based on population centres. A large proportion (32%) of Ballina visitors report staying with friends or relatives, suggesting visitor numbers (and therefore expenditure) could be distributed in line with population. Approximately 63% of the Ballina population lives near the coast. Assuming a producer surplus of 20%, this suggests that of the $140M spent by visitors annually, around $18M could be ascribed to the coastal zone based on the proportion of people that live near the coast.

Recreational fishing by residents and visitors is thought to contribute around $5.3M annually to the local economy, while commercial fishing is thought to contribute around $1M annually.

The recreational value of the beach, i.e. an economic value ascribed to the amenity that the beach provides, is estimated at around $5.1M annually.

2.2.4.1 Value of built and natural assets exposed to coastal hazard

It is not possible to quantify the potential reduction in value of the Ballina coastal zone resulting from coastal erosion because of the diversity of elements that make up this value and the complexity in determining their total value. In the most general terms, the activity-based and demographic-based economic values of the Ballina coast (both estimated at approximately $18M annually), and the recreation value of the beach (not coast) (estimated at $5.1M annually), are likely to reduce overall as a result of coastal erosion.

The economic impact of unmitigated coastal erosion as predicted in BMT WBM (2011) on private, community and natural assets is very difficult to quantify. Although there is very low formal analytical value in considering the *present* value of assets that are under coastal hazard threat by *future* estimated coastal erosion, such a summary does provide some context as to the nature and extent of the hazards in relation to assets.

Table 2.3 provides a simple summary of informal estimates of the present value of private and community assets that are within hazard zones. Note that the response category for all private property subject to coastal hazards is Category A, which is defined by OEH as "coastal protection works are considered technically feasible and cost-effective – funding is being sought for implementation"

Table 2.3 Estimated value of private and community assets at risk from coastal hazards

Private and community assets	*Number*	*Estimated average current value (2012 $)*	*Estimated total current value (2012 $)*
Risk Category 1 – Current Hazard Area, i.e. seaward of the immediate hazard line			
All types	0	0	0
Risk Category 2 – 2050 Hazard Area, i.e. seaward of Best Estimate Hazard Line for 2050			
Hotel	1	17,000,000	17,000,000
Apartments (luxury) – 1 block	14	600,000	8,400,000
Apartments (standard) – 1 block	12	350,000	4,200,000
Dwellings (fronting Pacific Parade)	30	1,500,000	45,000,000
Lennox Surf Life Saving Club	1	2,000,000	2,000,000
Approximately 25% of Lake Ainsworth Sport & Recreation Facility	-	-	4,000,000
Pacific Parade roadway, footpath, guttering, signage and associated infrastructure	-	-	940,000
Sewer Services	-	-	400,000
Water supply services	-	-	260,000
Electrical services	-	-	1,000,000
Telecommunications services	-	-	TBC
		Risk Category 2 total	*83,200,00*
Risk Category 3 – 2100 Hazard Area, i.e. seaward of Best Estimate Hazard Line for 2100			
Dwellings (fronting Pacific Parade)	7	1,500,000	10,500,000
Dwellings	27	800,000	21,600,000
Additional 25% of Lake Ainsworth Sport & Rec Facility (comprising more buildings)	-	-	6,000,000
Cliff Murray Lane roadway, guttering, signage and associated infrastructure	-	-	800,000
		Risk Category 3 total	*38,900,000*
		OVERALL TOTAL	**$122,100,000**

Notes:

- Values adopted from GeoLINK (2008)
- Average property values provided by Lois Buckett Real Estate, Lennox Head.
- Caravan Park business value of $6.5 million (not including land value) provided by Ballina Shire Council
- It has been assumed that even though the hazard line may only cut across a portion of a property, for the purposes of this study it has been assumed that the buildings would be affected and they are thus included
- Pacific Parade, sewer and water supply values provided by Ballina Shire Council (pers. comm., 12/06/07)
- Electrical Services value provided by Country Energy (pers. comm., 14/06/07)
- Telstra was unable to provide a value estimate of telecommunications infrastructure on Pacific Parade
- The current depreciated value of the land and infrastructure of the Lake Ainsworth Sport and Recreation Centre is estimated to be approximately $16 million

Table 2.4 provides a simple summary of estimates of the present value of natural assets and public open space that are within hazard zones. In addition to the overly simplified approach of assessing the effects of *future* impacts on *present* values, the valuation of the 'services' to the community provided by natural assets (generally measured in $/ha/year) is also subject intense debate. Nevertheless, the values are presented to provide some context as to the nature and extent of the 'value' of natural assets that are exposed to coastal hazard. The derivation of the valuation rates used in **Table 2.4** is discussed briefly in Section 4.5.6.2 of GeoLINK (2007).

Table 2.4 Estimated values of natural and public open space assets under threat

	Valuation rate (2012 $/ha/yr)	*Area lost 2050 (ha)*	*Value (2012 $/yr)*	*Area lost 2100 (ha)*	*Value (2012 $/yr)*
Coastal heath	19,920	76	1,514,000	159	3,170,000
Urban parkland	19,920	2	40,000	2	40,000
Beach	7,500	2	15,000	2	15,000
Lake Ainsworth	39,100	0	0	31.9 [a]	1,250,000
	TOTAL VALUE		**1,570,000**	**82,848**	**117,494**

[a] It is assumed that whole freshwater system and its associated 'value' would be lost should the lake be significantly and permanently breached

2.3 Future Coastline Uses and Conflicts

The quality of the 'coastal' experience in most instances is dependent on the quality of the environment. Quality of the environment in this context refers to both adequate ecological functioning and sufficient social capacity, i.e. a healthy ecosystem that meets the needs of all users.

The Ballina LGA's population is expected to increase from its current level of around 43,000 to 60,000 by 2026 (a growth rate of approximately 2% per annum). Much of this growth will reflect the current broad demographic pattern of two-thirds of the LGA's population living in the coastal zone.

In addition to local population growth, the LGA is becoming increasingly accessible to the large population centres of the Gold Coast and Brisbane as a result of highway upgrades. And increased levels of air travel mean that more visitors are arriving from more distant centres. While no estimates of expected tourism growth are presented in key documents, the growth is expected to be significant and will undoubtedly increase pressure on recreational resources.

The expected coastal hazards outlined in this section and in **Section** 3 indicate that coastal recession, and associated processes such as increased storminess, will lead to changes in the coastal environment that are likely to be adverse for recreation resources, however, the scale and precise nature of those changes is not clear.

Careful management through this CZMP and the Coastal Reserves Plan of Management will be necessary to offset and/or manage increasing pressure on the shire's coastal recreational resources resulting from these combined social and environmental changes.

3 Recommended Management Actions

3.1 Introduction

As discussed in **Section 2.1**, this CZMP focuses on the three main coastal hazards identified in WBM (2003) and BMT WBM (2011):

- Beach erosion, due to offshore movement of sand from the sub-aerial beach during storms or an extreme or irregular event;
- Shoreline recession due to sediment budget deficits (i.e. more sand leaving a beach and its embayment than entering it), and sea level rise; and
- Coastal inundation, due to large waves, resulting from extreme ocean storm events, overtopping dunes or seawalls and inundating the land behind.

Shoreline recession generally occurs over the long term and has been observed on many beaches of the Far North Coast as a dominant process in recent decades. Beach erosion is generally the result of a severe storm event, or series of closely spaced events, that can occur at any time and is generally followed by a period of accretion.

As a result of the variation in the nature and timeframe of the erosion components, the management actions to mitigate the threats associated with beach erosion will not necessarily mitigate the threats associated with longshore sediment transport differentials and sea level rise. However, some possible management actions to mitigate against long term erosion threats (e.g. seawalls and beach nourishment) are likely to be effective to a large degree against beach erosion. Conversely, some possible management actions to mitigate against beach erosion (e.g. temporary rock walls) may in fact *exacerbate* long term erosion threats if not implemented appropriately, and this may necessitate their removal following the abatement of the storm threat.

Cost-effective management of coastal erosion requires a set of complementary short-term (emergency) and long-term management actions to coordinate preparedness, mitigation and recovery in order to maintain coastline amenity.

- **Section 3.2** outlines the Emergency Action Subplan for Coastal Erosion (EAS) which guides Council's response to immediate coastal erosion emergency events in which beach erosion threatens the safety of people or destroys or damages any property (refer glossary). The EAS is separate from this CZMP.
- **Sections 3.3** to **3.7** present long term management actions to mitigate against coastal erosion due to longshore sediment transport differentials and sea level rise, which can also have beach erosion imposed on top of them.

3.2 Coastal Erosion Emergency Events

Coastal erosion emergency events are most likely to arise when severe storm conditions (cyclones or low pressure systems) generating strong onshore winds and large waves, coincide with high spring tides. Coastal erosion emergency events may also occur under relatively benign conditions where, due to the significant lowering of a beach profile as resulting from natural processes, waves are able to scour the back beach erosion escarpment resulting in landward recession of the escarpment. Coastal erosion and or inundation may exacerbate risk to development, infrastructure, and/or persons.

To manage these risks Council has prepared an Emergency Action Subplan for Coastal Erosion (EAS) that is separate but related to this CZMP. The EAS details actions to be carried out by Ballina Shire Council (Council), in response to a coastal erosion emergency event.

A coastal erosion emergency event is defined as a situation in which:

- beach erosion is imminent, is occurring, or has occurred; and

- this beach erosion endangers, or threatens to endanger, the safety or health of people or destroys or damages, or threatens to destroy or damage, any property and which requires a significant and coordinated response.

In addition to erosion, inundation of land and property due to wave overtopping dunes due to large swell conditions and/or diminished dune profiles may also be secondary effect of a coastal erosion emergency.

The purpose of the EAS is to outline Council's intended actions before, during and after a coastal erosion emergency. The emergency may or may not have triggered Ballina Shire Council's Disaster Management Plan (DISPLAN) or the State Storm Plan 2007.

Note that the term "coastal erosion emergency event" in the context of the EAS is limited to hazards associated with beach erosion, and does not include events such as Tsunamis or maritime emergencies.

Once implemented, the long-term coastal hazards management actions outlined in this CZMP will reduce the threat of beach erosion and coastal inundation hazards in the Lennox Head village area. However, even once all these works are in place, emergency management of public risk, coastal infrastructure, and beach access points will be an ongoing responsibility of council.

3.3 North and Central Seven Mile Beach

3.3.1 Background and Objectives

This beach unit extends north from the northern extent of the Lake Ainsworth Sport and Recreation Centre to the shire boundary with Byron Shire. Within the assessed 2100 planning period, there is no development under coastal hazard threat throughout this beach unit.

The broad management objective adopted for this beach unit is to allow coastal processes to proceed under monitoring. Coastal erosion is expected to take the form of a gradual landward movement of the beach and dune system without a substantial change to the nature or extent of these environments, but resulting in a net loss of the coastal heath. Long term recession distances are shown in **Table 2.1**, and estimated losses of coastal heath are shown in **Table 2.2**.

3.3.2 Management Plan

Due to the current absence of any development under coastal hazard threat, no physical management actions are recommended in this CZMP. However, under **Management Action M2** in **Table 4.2,** it is recommended that photogrammetric analysis is undertaken every six years to quantify the short and longer term beach changes taking place. This would provide an extension of the database of photogrammetry presently available providing accurate data and re-assessment of existing hazard estimates for consideration of any future action. Photogrammetric analysis of aerial photography should be undertaken on selected profile locations based on the profiles analysed previously for the hazard definition study (refer **Illustration 3.4**).

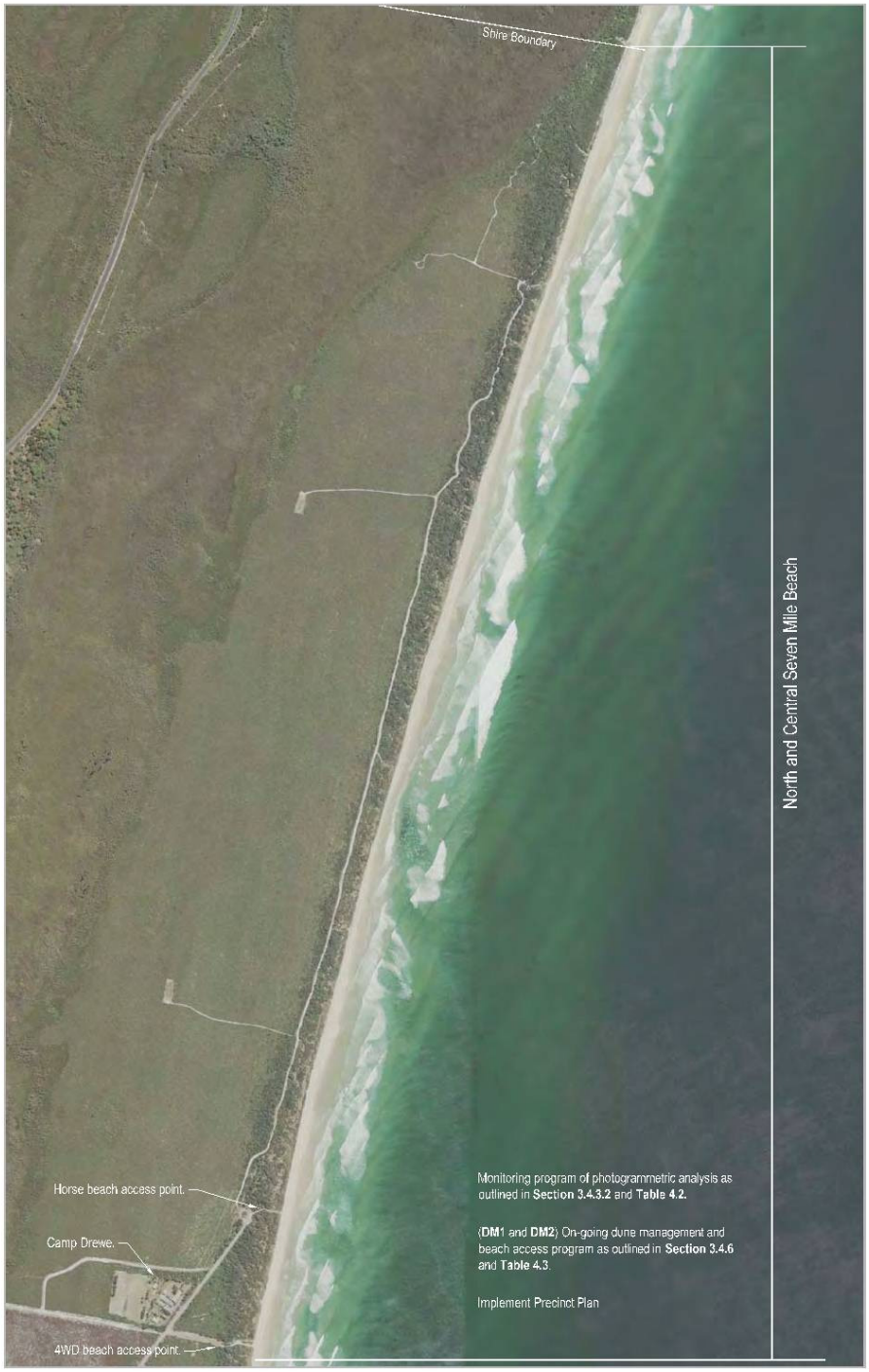
Dedicated horse and 4WD access points were recently installed on this beach unit. Although the hazard zones presented in BMT WBM (2011) do not extend as far north as these access points, it is likely that they would be exposed to beach erosion (due to storms or an extreme or irregular event) and shoreline recession (due to sediment budget deficits and sea level rise). Management of these beach access points is included under **Management Action DM2** in **Table 4.3**.

3.3.3 Precinct Plan (Precinct 1) Management Actions

A number of the actions presented in *Precinct Plan – Precinct 1* will aid in stabilising the fore-dunes north and Central Seven Mile Beach which will mitigate against coastal hazards and support public access, including:

- Management Objective 1.2 – Management of horses
  - (Now complete) Relocate horse beach access to end of Camp Drewe Road in conjunction with establishment of new vehicle access track. Rehabilitate eroded track through dune and stabilise for horse access.
  - Prohibit horses from dune and hind-dune by means of Code of Conduct and public promotion of restrictions.
- Management Objective 1.3 – Vehicle beach access
  - (Now complete) Re-locate vehicle beach access point to north of Lake Ainsworth Sports and Recreation Centre.
  - (Now complete) Close and repair existing vehicle access track at Lake Ainsworth
  - (Now complete) Close illegal tracks between the beach and the hind-dune track. Leave northern most track open for emergency access.
- Management Objective 1.6 – Dune stabilisation
  - Encourage the community to provide input into the development of future management strategies for coastal hazard reduction.
  - Ballina Shire Council continues and increases the level of support to Landcare groups and individuals engaged in native vegetation and habitat management.
- Management Objective 1.7 – Vegetation management
  - Prepare a Vegetation Management Plan for Seven Mile Beach
  - Prioritise actions in Vegetation Management Plans for Precinct 1
  - Support Community involvement in native vegetation management
  - Employ bush regenerator to assist community and work in areas not being managed by the community
  - Continue Bitou Bush aerial spray program and associated management

Source: Ballina Shire Council Date: December 2011



North

0 200m

North and Central Seven Mile Beach - Management Actions

GeoLINK environmental management and design | BMT WBM 0766640

Coastal Zone Management Plan for the Ballina Shire Coastline

Illustration 3.1

3.4 Lennox Head – North of Byron Street

3.4.1 Background and Objectives

This beach unit extends north from the northern end of the rock revetment seawall near the corner of Byron Street and Pacific Parade to the northern extent of the Lake Ainsworth Sport and Recreation Centre.

A buried seawall currently extends along much of this beach unit, however because details of its design and condition are unknown, any possible mitigating effect has not been included in the coastal hazard estimated discussed here, in WBM (2003) or in BMT WBM (2011).

As shown in **Illustration 2.1** and **Illustration 2.2**, BMT WBM (2011) estimates that there is currently no development under immediate coastal hazard threat in this beach unit. However, in the absence of any management intervention, assets on and fronting Pacific Parade are likely to be subject to coastal hazard by 2050. Similarly, assets as far landward as Stewart Street are expected to be subject to coastal hazards by 2100. It is important to note that the foundations of assets landward of these lines would be affected by a zone of reduced bearing capacity which would extend some metres landward of the top of the scarp. The actual extent of this zone is dependent on local conditions and the foundations affected and would require a professional assessment on a site by site basis.

The broad management objective adopted for this beach unit is to protect development landward of the beach rather than remove development and allow erosion to proceed, i.e. protect rather than retreat. Under the requirements of the CP Act the method of protection implemented under this CZMP must provide for a beach and dune system for recreational and environmental amenity, and to provide a buffer or 'store' of sand to accommodate beach erosion and shoreline recession.

BMT WBM (2011) notes that recent data show the general trend of shoreline recession in this beach unit to have reversed, at least temporarily, between 2003 and 2010. However, the present understanding of the long-term processes and behaviour of this beach system requires that the projected shoreline recession erosion hazard must be considered a probability for coastal management planning purposes. The uncertainty inherent in the present projections of future shoreline behaviour requires that costly protective nourishment and seawall construction works be undertaken only as and where required, as determined by ongoing beach and dune system monitoring.

With regard to coastal inundation (due to large waves overtopping dunes or seawalls), WBM (2003) estimates that Pacific Parade may be exposed to this hazard in the immediate term but this is unlikely to be significant. Although it does not consider coastal inundation directly, BMT WBM (2011) estimates the immediate hazard line to be seaward of that presented in WBM (2003) thus the threat of coastal inundation is assumed to be further reduced and not considered further.

Source: Ballina Shire Council Date: December 2011

North

0 200m

Lennox Head - Management Actions

GeoLINK environmental management and design BMT WBM 0766640

Coastal Zone Management Plan for the Ballina Shire Coastline

Illustration 3.4

3.4.2 Management Plan – Introduction

In response to Council's decision to protect rather than relocate assets, GeoLINK (2008) identified that the most effective strategy for this beach unit is the *Beach Nourishment with Seawall* option.

The primary recommended protection measure is beach nourishment to offset the long-term shoreline recession trend, provide a buffer against beach erosion, and maintain the environmental and recreational values of the beach. However, a seawall as a secondary landward 'last line of defence' along this beach unit is also recommended because:

- The coast may be subject to particularly severe erosion conditions that were not foreseen when preparing coastal erosion hazard estimates;
- The timely provision of sand for beach nourishment cannot be guaranteed; and
- The assets under potential coastal hazard threat, including Lake Ainsworth, are of significant value.

A preliminary concept design of the beach nourishment works has been determined on the basis that the long-term trend of shoreline recession will continue, and its rate is likely to increase in future due to sea level rise. However, the possibility that the shoreline recession rate may stabilise and/or recover naturally is provided for by a strategy that includes ongoing monitoring and 'trigger points' to indicate the need for major remedial works (see **Section 3.4.4.1**).

The alignment of the proposed seawall should be as landward as possible to maximise the space available for the beach and dune system. The alignment of the existing buried seawall may be suitable, however substantial repair and/or reconstruction along some parts will almost certainly be necessary for it to withstand severe wave attack. In order to determine its alignment, and the extent and detail of repair and reconstruction measures, an investigation by a qualified and experienced coastal engineer of the existing buried seawall is recommended (**Management Action 2014/2**).

Full implementation of all works required to protect against potential future long term recession of the whole beach unit is not required immediately. Thus the management plan for this beach unit comprises two main steps, investigations and monitoring followed by staged implementation of on-ground works.

Step 1 relates to investigations and monitoring and includes:

- (**Section 3.4.3.1**) Investigate feasibility for a long term sand supply for beach nourishment as a contingency measure to cater for the probability that the historical shoreline recession will continue into the future, exacerbated by sea level rise.
- (**Section 3.4.3.2**) Establish a comprehensive program of beach and dune monitoring integrating various monitoring methods to identify site specific beach processes, short and long-term trends, and trigger points for initiating detailed monitoring and protective works.
- (**Section 3.4.3.3**) Conduct coastal engineering assessment of the structural capacity of the existing buried seawall between Byron Street and the Lennox Head Alstonville Surf Lifesaving Club (SLSC) and the Lake Ainsworth Sports and Recreation Centre (LASRC). This investigation will identify requirements for upgrading their construction to a standard that will provide protection coastal hazards as a 'last line of defence'.

Step 2 relates to on-ground works of beach nourishment and seawall upgrade/construction as informed by results of Step 1 and is described in **Section 3.4.4**.

Section 3.4.5 outlines the statutory planning framework that underpins the management plan for this beach unit and **Sections 3.4.6** to **3.4.8** outline recommended regulations and actions for beach and dune management in order to support the management plan.

3.4.3 Management Plan – Investigations and Monitoring

3.4.3.1 Step 1.1 – Offshore Sand Source Investigation

Confirmation of suitable sources of offshore sand, and the associated design and approval of a program for extraction and placement of that sand, is likely to be a complex and lengthy exercise. Sand nourishment is the primary means by which assets will be protected under this CZMP.
Therefore **Management Action 2013/1** recommends that these investigations are started immediately, followed by design and planning (**Management Action2015/1**), and approvals (**Management Action ST1**) to ensure that works can commence when the trigger point is reached (see **Section 3.4.4.1**). Having the investigation, design, planning and approvals in place is also necessary for any seawall works to commence under this CZMP (see **Section 3.4.4**).

Key considerations with regard to sourcing nourishment sand from offshore include the following:

- the sand should be from outside the active beach system so that it provides a net gain rather than a redistribution within the system;
- the sand should be of suitable quality (grain size and colour) to ideally match the existing beach sand;
- sufficient quantities of sand should be available;
- the sand should be able to be obtained and placed without significantly adverse environmental impacts;
- government policies and regulatory requirements must allow for the operation (which they currently do not); and
- obtaining and placing the sand should be practical and economically viable.

Thus, any offshore sand source for beach nourishment must lie outside the zone of active beach sand movements. That is, it must be beyond the regions of:

- The active beach sand system including the beach, dunes, river and estuary inlets and sand supply from either longshore or offshore, and
- The normal cross-shore transfers of sand to and from deep water offshore from the beach, which occur during storm erosion events and subsequent beach recovery.

Any sand taken from within those areas would represent extraction from the beach system and beach sand supply that presently exists and would represent no net gain in the beach sand quantity.

It is known for example that the exchange of sand induced by storm erosion at the Gold Coast occurs out to water depths in excess of 15-16m. Recent research involving analysis of long term survey data (Patterson, 2007) shows that natural onshore supply of sand can occur from depths as great as 18-20m along the northern Gold Coast under a prevailing wave climate that is equivalent to that at Lennox Head. Thus, the required offshore sand source must be located at water depths greater than at least 20m to be confident of achieving the required net benefit. From a practical and economic perspective, dredging sand from sources at depths of 30-40m is feasible. Hence, the investigation should target seabed areas at depths between 20m and 40m.

Discussion of the most likely option for sourcing offshore sand for beach nourishment is included in Section A4.8 of GeoLINK (2008) some of which is reproduced below for completeness.

There are extensive known deposits of marine sand, directly compatible with the beach sand, on the inner continental shelf immediately offshore from the Ballina coastline. These constitute a potentially valuable resource for beach nourishment purposes. The deposits are readily accessible by modern dredging technologies and can be exploited economically and with less environmental impact than onshore extractive industries (Roy, 2001).

Specifically, a massive Inner Shelf Sand Body (ISSB) has been identified offshore from the Ballina to Cape Byron coastline, as illustrated in **Illustration 3.3** (Gordon et al, 1978; Roy & Stephens, 1980; Roy, 2001; Schluter, 1982, Colwell, 1982). The northern extent of this ISSB is commonly referred to as the Cape Byron Sand Lobe. However, it is substantially more extensive than is often recognised and its southern parts offer a potentially ideal source of nourishment sand for Ballina and Lennox Head. This sand has been derived from reworking of previously deposited coastal and marine sediments during repeated changes in sea level

associated with glacial and inter-glacial periods, the upper part forming the ISSB being of relatively recent Holocene age (i.e. since the last ice age).

Seismic information indicates the recent Holocene sand has a thickness of around 15-20 m across the 20-50 m water depth range. Sourcing the upper layers of this would be feasible, subject to detailed investigation to confirm sand suitability and acceptability of environmental impacts.

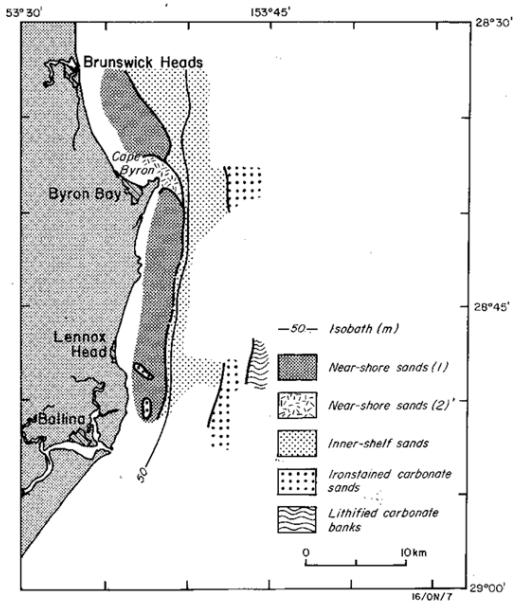


Illustration 3.3 Extent & Sand Types of Byron Sand Lobe (from Colwell 1982)

Nourishment has been undertaken successfully on the Gold Coast and in many other locations globally. At the Gold Coast, approximately 3.8 million cubic metres of sand was dredged from depths greater than 18 m below Mean Sea Level (MSL) and placed on the beach and in the nearshore zone (Murray, Robinson and Soward, 1993). Patterson Britton (2006) indicates a suitable depth limit for the Byron lobe of 17 m.

However, following proposals in the early 1980s and early 1990s for commercial sand extraction from offshore areas which did not proceed, the NSW Government adopted a contrary position with respect to sand extraction from the marine environment. Offshore sand extraction has not been an activity approved to date in NSW either for commercial purposes or for beach replenishment.

While much of the ISSB is within the gazetted boundaries of the Cape Byron Marine Park, there are also areas located to the south and outside the park which could be considered as a potential source of nourishment sand.

Any consideration of offshore sand extraction is expected to be subject to a determination on its own merit. However, such approval of a proposal to obtain offshore sand for beach nourishment cannot be assumed. Sand extraction is a designated development requiring the mandatory preparation of an EIS under NSW legislation. Such an EIS would need to be backed by significant scientific and engineering studies. As such, the potential use of offshore sand reserves for beach nourishment would be subject to further investigation and approval, which would require substantial time and investment.

The NSW Government currently maintains a position prohibiting extraction of off-shore sands based partly on concerns regarding over-commercialisation of this important natural resource. Clearly nourishment of public

beaches is not a commercial exercise although the market value of private property will certainly benefit if beach erosion and shoreline recession begin to have a more negative effect on values as they might be expected to do.

3.4.3.2 Step 1.2 – Monitoring Program

A clear picture of the changing nature of the beach is critical for timely and cost-effective management, primarily by means of identification of the trigger point for implementation of protective works. There are various monitoring methods available for Council to determine both short and long-term trends of shoreline recession rates; current condition of the beach and dune; and whether trigger points have been reached to initiate detailed monitoring or protective works. These include:

- Photogrammetric analysis (minimum basis of monitoring program);
- Land-based surveys;
- Low cost beach monitoring;
- Bathymetric surveys; and
- Coastal conditions monitoring system.

Photogrammetric analysis

The recommended monitoring program is based on a minimum of on-going photogrammetric analysis of the aerial orthophotos provided by the NSW Government, which may be complemented by the other monitoring methods, as described below. The analysis should be continued on the profile locations based on the profiles analysed previously (refer **Illustration 3.4**) which underpin the findings of WBM (2003) and BMT WBM (2011). These profiles also cover the beach unit Lennox Head, south of Byron Street, which is discussed in more detail in **Section 3.5**.

The NSW Office of Environment and Heritage provides suitable aerial photography approximately every three years and analysis of these images is recommended to be undertaken at the same frequency for this beach until a sufficiently clear trend has been established. BMT WBM (2011) shows that a recent short-term trend of accretion overlays the long-term trend of recession; however this reversal is expected to be temporary.

Ideally the photogrammetric analyses should be complemented with land-based surveys as described below.

For cost-effectiveness, flexibility may be allowed on the timing of the aerial photography to suit opportunistic photography that may be available from time to time and/or to fit with other activities of the aerial photograph contractor. Otherwise, special-order photography may be needed. The NSW Government photogrammetry facilities would be capable of undertaking the analysis. Should analysis costs be a substantial limiting factor, the photography should be obtained and archived for analysis at a later time when funding is available.

Results of the photogrammetric analyses should be compiled and reviewed every six years, or following a major storm, or as determined necessary from visual inspections (refer **Management Action M10**), in conjunction with results of land-based surveys discussed below if available. The review should:

- Describe the current condition of the beach and dune in relation to assets and projected coastal hazards;
- Quantify recent changes and provide revised short-term and long-term trends;
- Consider recommendations with respect to trigger points for protective works as outlined in **Section 3.4.4.1**; and
- Monitor the performance of beach nourishment works that may be implemented in future.

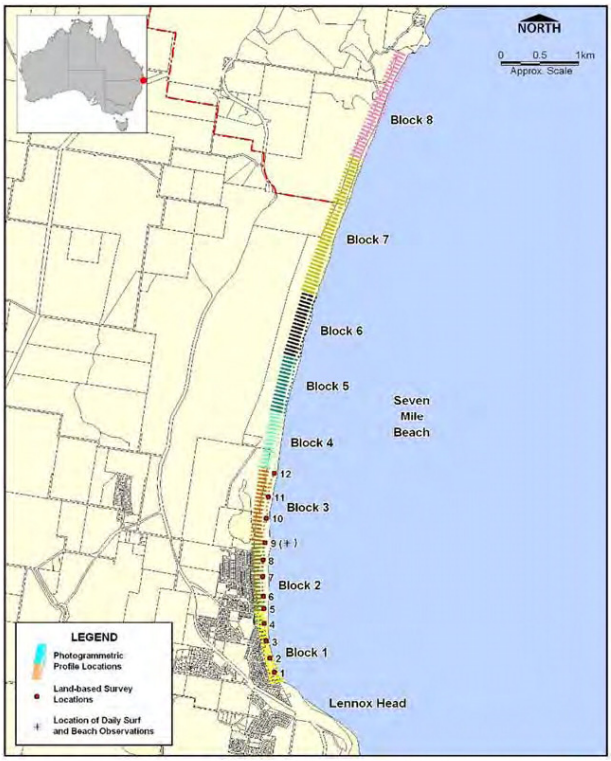


Illustration 3.4 Proposed Land-based Surveys and Photogrammetry Sections – Lennox Head

Land-based surveys

It is recommended that photogrammetric analyses are complemented with land-based surveys to provide greater spatial definition, especially at locations where assets may be under immediate coastal hazard threat as discussed below.

The surveys should extend across the beach and dune from the low water line to at least as far landward as the 50 year hazard line in undeveloped areas. This will, at the selected locations, enable quantification of:

- Changes in the quantity of sand in the upper beach/dune system;
- The volume of sediment loss associated with storms or an extreme or irregular event;
- Progressive longer term changes in the shoreline position and any long term trend of erosion or accretion.

The recommended locations of surveys are shown in **Illustration 3.4**. It is possible that historical survey information, collected in conjunction with bathymetric surveys discussed below, is available. If this is the case the location of land based surveys should include consideration of historical surveys to simply the establishment of trends based on consistent survey profiles across the dune and beach.

Extensive land-based surveys may not be possible or cost-effective depending on the resources available for monitoring. Thus it is recommended that surveys are conducted in locations where the top of the erosion scarp is less than 35 m from the line of assets to be protected. The recommended distribution of land-based surveys when this condition is triggered is shown in **Illustration 3.4.** Ideally, the recommended frequency of surveys would be:

- Immediately following major erosion events;

- Six monthly over the following five years; and
- Annually after the first five years.

BMT WBM (2011) shows that the 1999 erosion scarp is within 30 m of the Pacific Parade roadway which suggests that survey locations 5, 6 and 7 shown in **Illustration 3.4** should be surveyed as soon as possible (**Management Action M4**).

Land-based survey information, if collected, should be included in the summary and compilation of monitoring results discussed under photogrammetric analysis above (**Management Action M10**).

Low Cost Beach Monitoring

It is feasible to undertake simple but effective beach monitoring without significant expense. This may involve input from Council staff, surf club members or volunteer residents, with minimal technical knowledge or expertise. Typically, it could include:

- Volunteer daily observations of waves, currents and sand transport at (say) the SLSC. This would entail a trained observer using established observation techniques to record reasonably accurate results (Patterson, 1985; Patterson & Blair, 1983).
- Regular (say monthly) survey of selected beach cross-sections using simple techniques. This best involves the installation of a graduated reference pole levelled to Australian Height Datum (AHD) at the site. This would allow a trained observer to record level versus distance measurements based on line of sight to the horizon.
- Visual inspections of the rock seawall following each substantial storm erosion event to monitor the integrity/stability of the rock wall.
- Recording of storm intensity data including barometric pressure, sea level, wind speed and direction, and wave height and direction, and correlation of this data with the extent and nature of beach erosion. This would assist in consideration of trigger points and increasing the accuracy of forecasting erosion from storm events.

Such observation procedures have proven to be reasonably accurate and an invaluable data resource in other locations. They are described in more detail in **Appendix B**. The cost of such a program is likely to be less than $10,000 per year.

Bathymetric Surveys

While a northerly longitudinal movement of sand is the dominant long-term process affecting sediment budgets on Ballina beaches, there is also considerable cross-shore movement at times, which can have a much greater effect on beach conditions over the short-term.

It is understood that bathymetric surveys off the Ballina coastline have been conducted on a number of occasions over the last century or so and most recently in 2011, however the survey records have not been reviewed to inform this CZMP. A review of bathymetric survey records and an assessment of their usefulness are recommended under **Management Action M5**.

Integration of this historical bathymetric data and the results of photogrammetric analysis *may* improve understanding of cross-shore movement of sand and how it relates to beach and dune condition and improve the accuracy of coastline modelling and erosion prediction. If this is the case, then contemporary bathymetric surveys would contribute, with other data, to improving the level of certainty around the likelihood and extent of beach recovery, particularly following beach erosion. This may enable more strategic allocation of resources.

The location and frequency of bathymetric surveys will be dependent on a number of factors, including:

- The findings of the existing data review – if existing bathymetric data are suitable, collecting new data in a way that allows for integration with existing data may allow better analysis of historical trends and relationships;
- Funding – compared to photogrammetric analysis and land-based surveys, bathymetric surveys are likely to be expensive with lower cost-benefit in terms of trend analysis and hazard estimation;

- Opportunistic availability – establishment costs may be avoided if the survey vessel and/or equipment is available locally for some other purpose; and
- Integration with other monitoring – to obtain a good 'snapshot' of beach condition bathymetric surveys ideally should occur at a similar time to the land-based surveys and/or photogrammetric analyses.

Bathymetric survey information, if collected, should be included in the summary and compilation of monitoring results discussed under photogrammetric analysis above (refer **Management Action M10**).

Coastal Conditions Monitoring System

Coastal Conditions Monitoring System ('CoastalCOMS') is an automated real-time observation and data management service for coastal monitoring. Developed by Coastalwatch Pty Ltd, the system uses video recordings, raw data from climatic and other physical processes, and processed information derived from raw data to monitor and/or predict a range of beach conditions.

In relation to coastal hazard management, the system can measure shoreline position by geo-referencing the position of the water with respect to a fixed video camera. Calibrated using existing beach survey information this system can provide real-time monitoring of the volume of sand on a particular beach, informing decisions on the level of coastal hazard threats and management responses.

A camera managed by Coastalwatch Pty Ltd is currently in place on the Lennox Alstonville Surf Life Saving Club. The video feed from this camera may be suitable for determining the level of coastal erosion hazard at Seven Mile Beach using image interpretation software provided and managed by Coastalwatch Pty Ltd.

3.4.3.3 Step 1.3 – Assessment of Existing Buried Seawall

The existing seawall buried under the dune east of Pacific Parade was built between 1977 and 1980. As its structural design, construction and present condition are unknown **Management Action 2014/2** requires that it be assessed with respect to current best practice design standards by a suitably qualified and experienced coastal engineer.

This assessment would need to provide recommendations to either upgrade or reconstruct the existing structure to an adequate standard, including as a minimum:

- An adequate height of structure to prevent excessive wave overtopping when exposed but allow for adequate coverage for vegetation establishment and recreational amenity when buried by the dune;
- A flexible rubble mound structure that may adapt its shape without structural failure and allowing practical repair and/or maintenance in the event of damage during extreme wave attack;
- A toe foundation embedded soundly in the upper beach such that it will not be significantly undermined during severe wave attack;
- A backing filter layer (or layers) of either fine rock (gravel) and/or geotextile fabric over the sand, grading up to the larger armour rock in such way that neither the sand nor the finer rock may be lost through the structure during wave attack;
- Two layers of armour rock of adequate size placed randomly with void spaces to minimise wave uprush and act to absorb the wave energy;
- A suitable design for the northern end to protect against adverse 'end effects' and/or out-flanking by erosion behind the last section of rocks, most effectively involving a landward return of the alignment; and
- Rehabilitation of the land behind the seawall as required for stability, access and control.

A conceptual design section is shown in **Illustration 3.6**. Use should be made of any rock in the existing seawall as much as feasible, particularly where it is well bedded into the beach to act as a toe foundation, thus minimising the cost of rock supply.

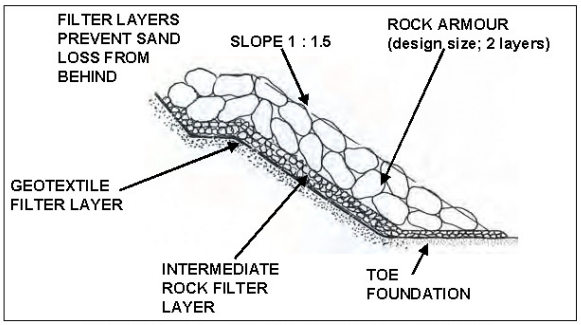


Illustration 3.5 Typical Seawall Design Section

At the northern end of the seawall, a landward 'return' to the seawall is required to tie it into the dune, as shown conceptually in **Illustration 3.6**. It should be noted that the final detail of the end design will need to be adapted to the dune topography at the time and the return extended sufficiently far landward to avoid outflanking by wave erosion.

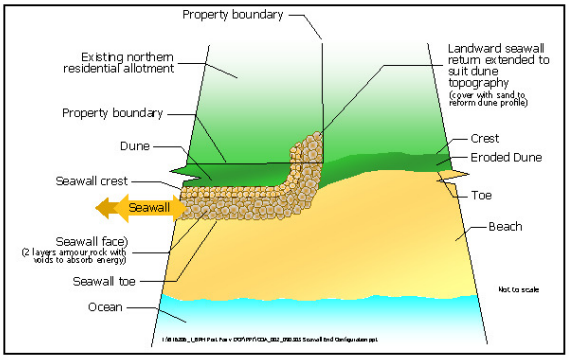


Illustration 3.6 Conceptual Seawall End Configuration

This seawall investigation is recommended for the first year of the CZMP implementation under **Management Action 2014/2**. It will most probably include excavation and assessment of the seawall at a number of randomly selected locations spread along its length to obtain a reliable representation of its present alignment and status. The outcome should be a detailed status report, together with design drawings and cost estimates for the required upgrade works.

3.4.4 Management Plan – Protective Works

Section 55C of the CP Act requires that this CZMP "*...[protects] and [preserves] beach environments and beach amenity...*" and ensures "*...continuing and undiminished public access to beaches...*".

As discussed above, beach erosion and shoreline recession are expected to occur in this beach unit over the long term. Under these processes the beach and dune are expected move landward unless the processes are reversed by beach nourishment or stopped by a terminal seawall. If a seawall is used *without* beach nourishment the landward movement of the beach and dune will manifest in a lowering and narrowing of the beach 'against' the seawall, impacting on environmental and recreational amenity which would be contrary to the CP Act.
Therefore, under this CZMP, works on upgrading or reconstructing the existing buried seawall, or installation of a new seawall, *cannot* commence without a beach nourishment program in place for this beach unit.

3.4.4.1 Beach Nourishment Trigger Point

While long term processes may result in gradual depletion and recession of the beach profile, the potential for beach erosion is expected to define the extent of coastal hazard threat at any particular time. Beach erosion is primarily volume based and the landward extent of the erosion dependent on the beach profile at the time of the event that results in the beach erosion.

BMT WBM (2011) identified the sediment loss associated with beach erosion as being 200 m^3/m above MSL. This estimate of volumetric loss is based on the beach being in a relatively accreted state. The loss may be less than this if the beach is already depleted, although depleted conditions clearly do not reduce coastal hazard threat.

Therefore, in principle, the trigger for implementation of beach nourishment is reached when the volume of sand available in the beach profile seaward of the 'line of protection' is less than 200 m^3/m. Identification of when this trigger point is reached requires:

- determination of the 'line of protection', landward of which property or infrastructure is to be protected and along which a seawall would ultimately be constructed;
- quantification of the sand that is available seaward of that line and above the limiting design storm profile (see below); and
- assessment of the trends (see below) in the volume of sand available above the limiting design storm profile.

Determination of the 'Line of Protection'

This is closely related to the alignment of the proposed seawall and is discussed in **Section 0**.

Quantification of Storm Profile

For calculation purposes, it is recommended that a simplified design storm profile be adopted as defined in WBM (2003). This includes the following parameters:

- An erosion scarp slope of 1 in 1.5 which allows for some slumping following the storm event.
- The toe of the erosion scarp at RL 2.3 mAHD as observed regionally.
- An eroded beach slope of 1 in 20 from the toe of the scarp (RL 2.3 mAHD) down to mean sea level (RL 0.0 mAHD) as a representative average.

This simplified design storm profile is shown in **Illustration 3.7**. In positioning the profile for the limiting position, the top of the erosion scarp should be located at the point at which protection is required and the seawall is to be constructed. The volume of sand in the dune and beach above this storm profile down to mean sea level (RL 0.0 mAHD) can then be calculated.

The trigger for construction of the seawall will be when this beach profile volume reduces to the assessed design beach erosion volume or less, nominally 200 m^3/m above MSL for the beach in a relatively accreted state (that is, following a period of relatively calm conditions and natural rebuilding).

Further discussion is provided below relating to the trigger for the detailed assessment of the beach profile volume.

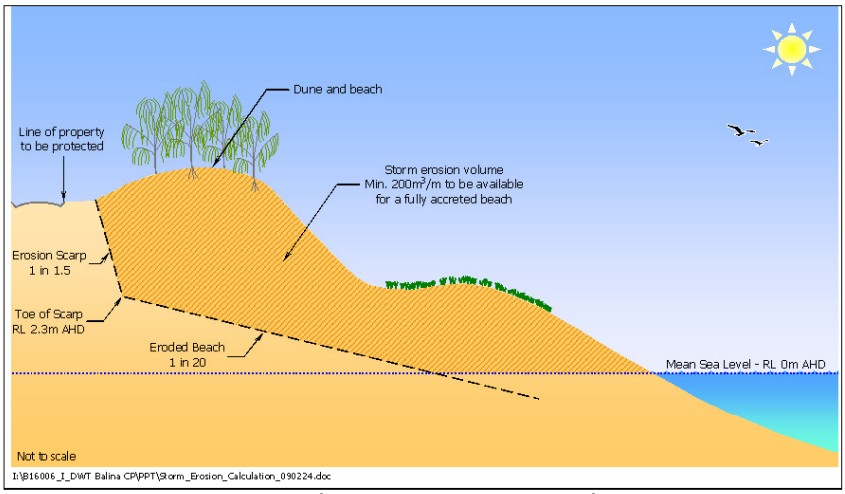


Illustration 3.7 Conceptual Storm Profile

Assessment of Trends

The beach profile, i.e. the sand available above the storm profile, will vary in response to prevailing conditions. Assessment of long term trends of available sand, on which shorter term fluctuations may be superimposed, will be necessary to contextualise the significance of the beach profile volume when it is close to 200 m^3/m above the storm profile. This limit as the trigger for beach nourishment will be reached through depletion and recession of the beach as a result of gradual long term processes; however establishment of any ultimate threat of damage to assets is likely to be a result of beach erosion.

Following storm activity the remaining beach profile volume may be less than the design trigger value of 200 m^3/m above AHD. However, this may not trigger the need for beach nourishment if the long-term rate of shoreline recession is low or even temporary accretion is evident (as exhibited between the preparation of WBM (2003) and BMT WBM (2011)). On the other hand, beach nourishment would be triggered if the longer term trends indicate that the specified design volume above the limiting storm profile will not return sufficiently in the short to medium term.

Therefore, it is recommended that specific coastal engineering advice be sought to assess both the capacity of the existing seawall (as outlined in **Section 3.4.3.3)**, and trends in beach profile volume (as outlined in **Section 3.4.3.2)**, to determine the consequent threat to property and resultant need for beach nourishment.

3.4.4.2 Beach Nourishment Design Considerations

To nourish depleted nearshore areas as well as the upper beach, provision should be made for the placed sand to extend across the full beach profile as shown in **Illustration 3.8**. If the sand is placed only on the upper visible portion of the beach, redistribution will quickly occur to establish an equilibrium profile, giving the impression that the sand is 'lost' and the project is a failure. In such a case, the sand is, in fact, not 'lost' but remains in the active system providing an overall net gain commensurate with the quantity remaining after cross-shore distribution.

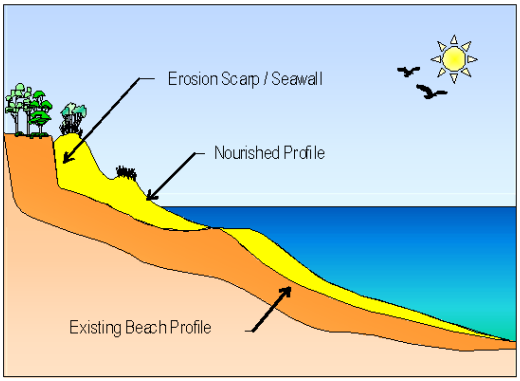


Illustration 3.8 Typical Beach Nourishment Profile

A detailed design of the nourishment scheme would be required to optimise the quantity of initial nourishment and the re-nourishment frequency/quantity. In addition to the beach profile at the time of nourishment, design considerations would include

- available funding and cost-sharing arrangements with neighbouring Councils;
- the operating cost and availability of a dredging barge;
- the requirements of other beach nourishment projects (beach nourishment will undoubtedly occur as part of a coordinated program servicing other local government areas); and
- environmental issues.

The beach profile at the time of nourishment and, particularly, the results of the monitoring and identification of trigger points for action will guide nourishment volumes and locations. However, for planning purposes and on the basis of presently available information and assuming a fully depleted beach, it is considered that an initial quantity of about 600,000 m³ will be necessary. The required nourishment volume per lineal metre of beach is expected to vary from 500 m³/m seaward of Byron Street to 250 m³/m seaward of the Lake Ainsworth Sport and Recreation Centre (LASRC). This would provide sufficient sand to accommodate the short term storm volume per lineal metre demand of 200 m³/m above the storm profile. Subsequent re-nourishment would be expected to be required every 20-30 years (depending on storm frequency and intensity, erosion trends and sea level rise) with a volume of approximately 400,000 m³, or sufficient to accommodate the beach erosion loss of around 200 m³/m above the storm profile.

The sand would be placed predominantly on the upper beach and near shore zone out to about the normal position of the offshore bar. Ideally the quantity of sand should be sufficient to allow a dune of about RL 6.0 mAHD to be formed and the general beach to widen by about 20 m to 35 m. Both alongshore and across-shore dispersal under the prevailing waves and currents will integrate nourished sand into the normal active system. The beach will be expected to adopt its natural dynamic shape, subject to normal erosion and accretion cycles associated with storm erosion and subsequent beach recovery.

While beach nourishment may affect the ecological values of the beach and nearshore areas, the nourishment sand would be placed in the active zone. Here the natural environment is one of substantial fluctuations and disturbances to which the ecological communities adapt. As such, while there may be some short term ecological impacts, in the longer term the environment will adapt and recolonise to behave as a natural beach system.

3.4.4.3 Seawall Trigger Point and Design Considerations

The beach nourishment program described in **Sections 3.4.4.1** and **3.4.4.2**, subject to detailed design, would be adequate to prevent damage to assets from coastal hazards. However, a seawall as a secondary landward 'last line of defence' along this beach unit is also recommended because:

- The coast may be subject to particularly severe erosion conditions, or a series of beach erosion events, that result in a volumetric loss exceeding the current estimate of 200 m³/m described in **Section 3.4.4.1**;
- The timely provision of sand for beach nourishment cannot be guaranteed; and
- The assets under potential coastal hazard threat, including Lake Ainsworth, are of significant value.

Section 3.4.3.3 provides a basic outline of the concept design requirements of the seawall. The alignment of the seawall will follow the 'line of protection' landward of which property or infrastructure is to be protected. It is recommended that the seawall is aligned as far landward as possible to maximise the potential to retain a sandy beach seaward of the wall. Specific considerations in this regard are as follows:

- For the area between Byron Street and the Surf Lifesaving Club, it is recommended that the seawall be as close to Pacific Parade as possible while balancing the future amenity provided by the beach with that provided by the grassed public open space between the beach and the roadway. The key considerations relating to the alignment include the following:
  - Investigations may show that the existing buried seawall already offers substantial protection, in which case there would be significant economic savings associated with following its alignment.
  - The further seaward the alignment of the seawall, the sooner beach amenity can be expected to be reduced due to the estimated shoreline recession occurring "against" the seawall. These reductions in beach amenity will be in the form of a gradual increasing frequency with which public access along and general use of the beach will be restricted due to combinations of low sand supply and tide levels. Such effects already occur on occasions as a result of the seawall south of Byron Street.
  - The further landward the alignment of the seawall, the less grassed public open space will ultimately remain once shoreline recession has occurred up to the seawall.
  - It is likely that the unique amenity provided by the beach will be valued more highly by the community than the amenity provided by the grassed public open space, thus indicating an alignment as close to Pacific Parade as possible is preferred.
- Given that relocating the Surf Lifesaving Club building is not likely to be viable and that it does not protrude substantially further seaward of the general alignment of Pacific Parade, the wall alignment could extend seaward of this structure.
- Between the Surf Lifesaving Club and the Lake Ainsworth Sport and Recreation Centre, the primary protection requirements are preventing a breakthrough to Lake Ainsworth and maintaining access between those centres. Accordingly, the seawall could be located further landward here; however consideration of increased interaction of seawater with the freshwater ecosystem of the lake will need to be considered.
- At the Lake Ainsworth Sport and Recreation Centre, the seawall works will need to be integrated with the existing upgraded seawall in front of the centre constructed in 1997.

All investigations, planning, designs and approvals for beach nourishment must be in place before works on upgrading or reconstructing the existing buried seawall, or installation of a new seawall, can commence under this CZMP.

It can be seen from **Illustration 2.1** that the immediate hazard line is landward of the assumed alignment of the existing buried seawall, but is seaward of Pacific Parade along the length of the roadway. Thus, BMT WBM (2011) estimates that the existing buried seawall will be exposed in the next major beach erosion event, but no major assets are under immediate coastal hazard threat. (The Lennox Head Alstonville SLSC and the southern end of Pacific Parade are possible exceptions to this and are discussed briefly below.)

Therefore, once a beach nourishment program is in place, it is recommended that seawall works commence following a beach erosion event that exposes the existing seawall, based on the following reasons.

- Significant excavation of the *existing* dune profile would be required to implement seawall works, whether these works comprise repair, reconstruction and/or relocation of the existing buried seawall, installation of

a new seawall, or some combination. The process of beach erosion will do much of the excavation that is necessary for the seawall works.

- North of Foster Street the immediate hazard line is approximately 20 m seaward of the Pacific Parade roadway indicating it is currently extremely unlikely that major assets will be damaged by beach erosion, even if more than 200 m³/m of sand is lost in the beach erosion event. Thus, under the estimates put forward in BMT WBM (2011), there is currently very little risk in waiting for the beach erosion event to occur.
- The natural capacity of the dune will be severely reduced during the works period as a result of the excavation, whether it is done by beach erosion or mechanically. While a storm resulting in significant beach erosion can occur at any time, the historical record shows that such events tend to be isolated. Hence it is less likely that a beach erosion event will occur shortly after one has just occurred.

Wave climate data shows that mean peak wave period and mean significant wave height are lowest in spring and summer for the Byron Bay region (Shand et al, 2010). Therefore seawall works ideally would be carried out during this time of year, although a suitable beach erosion event should be the primary determining factor for the timing of seawall works.

The approach of waiting for beach erosion to occur before commencing seawall works may expose the southern end of Pacific Parade roadway and the Lennox Head Alstonville SLSC to coastal hazard threat. **Illustration 2.1** shows that the immediate hazard line is seaward but very close to the Pacific Parade roadway between Byron Street and Foster Street, and particularly close south of Lennox Street. Considering the effect of the zone of reduced bearing capacity Pacific Parade may currently be under immediate coastal hazard threat between Byron Street and Lennox Street. If more than 200 m³/m of sand is lost due to beach erosion this threat may extend north of Lennox Street. For the same reasons, the SLSC may be under coastal hazard threat also as shown in **Illustration 2.2**. These risks can be managed by one of two ways:

- Establish a beach nourishment program and conduct short stretches of seawall works between Byron Street and Lennox Street, or as far north as Foster Street, and seaward of the SLSC, without waiting for a beach erosion event; or
- Conduct seawall works *outside* of this CZMP as either:
  - "Foreshore management activities" permitted under *State Environmental Planning Policy (Infrastructure) 2007* (refer **Section 3.4.5**); or
  - "Emergency coastal protection works" which are strictly defined under Part 4C of the CP Act. The nature and duration of such works is strictly limited and would require Seven Mile Beach to be included in the schedule of authorised locations for such works to be placed which it currently is not.

There is no act or regulation that specifically prohibits the construction of a seawall in the absence of a beach nourishment program, however, such works could not occur under this CZMP as defined under the CP Act.

3.4.5 Statutory planning requirements for protective works

Clause 128 of *State Environmental Planning Policy (Infrastructure) 2007* defines 'waterway or foreshore management activities' to include:

> *coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways.*

The beach nourishment proposals are clearly included in this definition, and the seawall works are effectively *foreshore stabilisation works* and so also constitute waterway or foreshore management activities.

Clause 129 of the Infrastructure SEPP provides that:

> *Development for the purpose of waterway or foreshore management activities may be carried out by or on behalf of a public authority without consent on any land.*

The protective works, therefore, will not require development consent. They are, however, considered to be an *activity*, pursuant to the provisions of Part 5 of the *Environmental Planning and Assessment Act, 1979*.

Section 111 of the Act requires that an authority proposing to undertake an activity must *examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*. This is normally undertaken by the preparation of a Review of Environmental Factors (REF).

However, if the activity is likely to significantly affect the environment (including critical habitat) or threatened species, populations or ecological communities, or their habitats, an Environmental Impact Statement (EIS) would need to be prepared and considered (note: the Act specifies public exhibition requirements for an EIS).

Pursuant to Section 38 of the *Coastal Protection Act 1979*, a public authority shall not, without the concurrence of the Minister:

(a) carry out any development in the coastal zone, or

(b) grant any right or consent to a person:

i. to use or occupy any part of the coastal zone, or

ii. to carry out any development in the coastal zone,

if, in the opinion of the Minister, as advised from time to time by the Minister to the public authority, the development or the use or occupation may, in any way:

- *be inconsistent with the principles of ecologically sustainable development, or*
- *adversely affect the behaviour or be adversely affected by the behaviour of the sea or an arm of the sea or any bay, inlet, lagoon, lake, body of water, river, stream or watercourse, or*
- *adversely affect any beach or dune or the bed, bank, shoreline, foreshore, margin or flood plain of the sea or an arm of the sea or any bay, inlet, lagoon, lake, body of water, river, stream or watercourse.*

Under the Coastal Protection Regulation (2004), a person (including a public authority) must not, without the concurrence of the Minister, carry out development on any part of the coastal zone that is below the high tide mark, excluding estuaries, lakes or artificial harbours. Beach nourishment works are very likely to be considered development below the high tide mark.

Council will need to liaise with the State Government to determine whether the Minister's concurrence will be required in this case.

The beach nourishment works are likely to have some impact on marine vegetation requiring approval pursuant to Clause 204A of the *Fisheries Management Act 1994*.

The beach nourishment works will be within the Cape Byron Marine Park. Pursuant to clauses 19 and 20 of the *Marine Parks Act 1997*, the determining authorities will need to consider the objects of the act, the objects and permissible uses relevant to the park zoning in which the proposed work will take place (i.e. Habitat Protection Zone), and any marine park closures.

There is no act or regulation that specifically prohibits the construction of a seawall in the absence of a beach nourishment program, however, such works could not occur under this CZMP as defined under the CP Act.

3.4.6 Beach and Dune Regulation and Management

3.4.6.1 Regulation of Beach Management

Apart from the need for restoration of the beach and upgrade of the seawall as provided for in this CZMP, coastline management practices undertaken and/or regulated by Council along the developed parts of the beach should include the following:

- No sand is to be removed and the dune vegetation protected to prevent wind erosion along the beach and dune system;
- For any new buildings constructed on the dune beyond the set-back, consideration should be given to excavating sand from those developments and returning it to the beach system, with building fill being imported as needed from outside the beach/dune system;

- In the event of future erosion back to the seawall, regular visual inspection and maintenance of the rock seawall should be undertaken as needed to ensure safety and structural stability;
- Public access to the beach should be limited to controlled public paths and/or stairs at suitably spaced locations to ensure convenient and safe access to and from the beach;

3.4.6.2 Regulation of Activities in Undeveloped Dune Areas

It is recommended that Council develops guidelines to regulate works and activities within the potential erosion hazard zones. This may involve integration with relevant regional and state planning provisions. The dune system should be managed in accordance with the methods and procedures recommended by OEH. Such management may include planting and protection of native dune vegetation, clearing of weed species and provision of controlled access across the dunes.

General regulations to protect the natural dune system where alternative provisions do not apply could include:

- No structures may be erected or interference caused within the immediate erosion hazard zone, beach or nearshore areas. Such structures and interference includes buildings, roads, car parking areas, facilities, services, seawalls or other equivalent works;
- No sand is to be removed from the beach system (onshore and offshore) – this does not relate to sand for beach nourishment which by definition is sourced from *outside* the beach system;
- No sand is to be removed and the dune vegetation is to be protected to prevent wind erosion along the dune system; and
- No future subdivision of land that would provide additional building lots wholly or partially seaward of the 2100 hazard line will be permitted unless it can be shown that buildings provided for in the subdivision will be located wholly landward the 2100 hazard line.

3.4.6.3 Dune Rehabilitation and Management

Rehabilitation and management of dunes to maximise their natural protective functions as a physical barrier and a source of sand during periods of erosion, is generally a cost-effective and ecologically sensitive means of mitigating against coastal hazards. Best-practice rehabilitation and management methods are set out in the *NSW Coastal Dune Management Manual* (DLWC, 2001).

Native foredune vegetation, generally comprising grasses and vines, is fundamental to dune health by binding sand that is in already place or trapping aeolian sand following an erosion event. This effect can also be mimicked by the installation of dune fencing. Therefore dunes can be managed in various ways including:

- Conduct active regeneration (planting) in accordance with guidelines and vegetation management plans;
- Install dune fencing in accordance with *NSW Coastal Dune Management Manual* (DLWC, 2001);
- Remove invasive species and weeds;
- Manage pedestrian access in high traffic areas by installing signage, fencing and designated pathways; and
- Work with stakeholders to restrict 4WD access to key locations and conduct compliance and enforcement activity to limit inappropriate access and damage due to irresponsible 4WD behaviour.

Council and numerous dedicated volunteer groups are already active in Ballina implementing such initiatives, and in many cases have been instrumental in maintaining the health of dunes. It is recommended that Council maintains this program as outlined in **Table 4.3**.

BMT WBM (2011) notes that the dune system of this beach unit is currently in an acceptable condition, particularly as the foredune has developed recently in the absence of severe erosion. However, there has been some localised beach erosion in recent times and degradation of native dune plants and reduced dune level have occurred as a result of inadequate control of pedestrian access. Consequently, the existing foredune needs to be managed in certain locations and those degraded and poorly vegetated areas rehabilitated and managed to facilitate natural dune processes. **Management Action DM1** in **Table 4.3** outlines the broad elements of dune management actions, noting a focus on this beach unit.

Conceptual guidelines for management of the dune system are illustrated in **Illustration 3.9**. This shows the use of control fencing in highly trafficked areas to protect the natural system by. **Illustration 3.9** also indicates the desired nature and location of control fencing, vegetation development and surface mulching needed both as part of any nourishment works and following major erosion events.

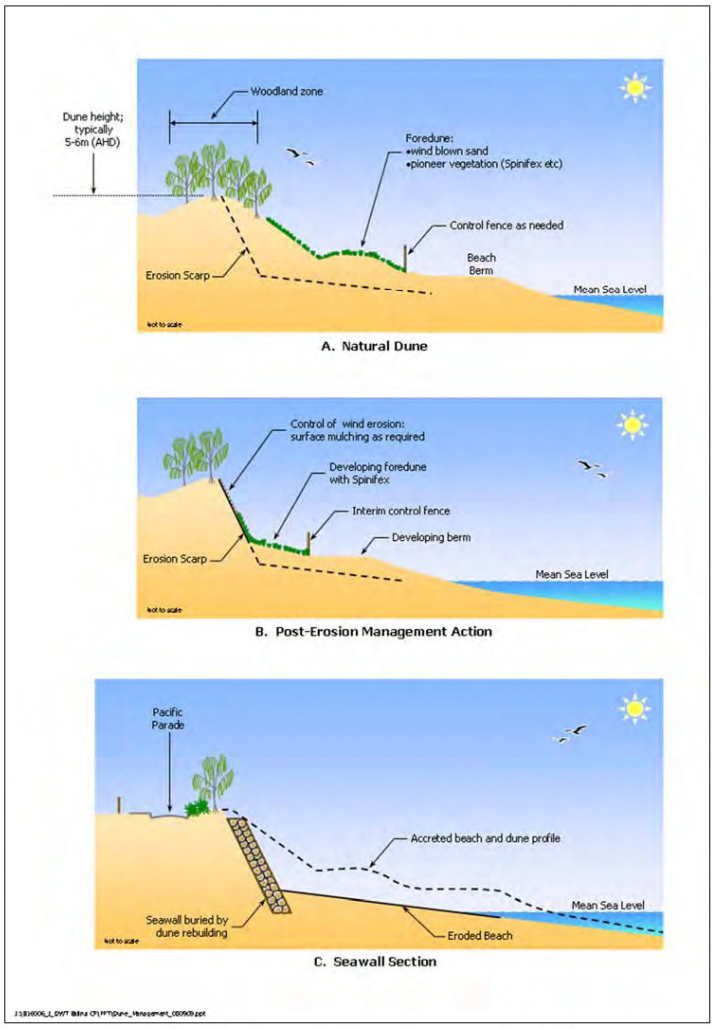


Illustration 3.9 Conceptual Dune Management Guidelines

3.4.7 Stormwater drains

In addition to the broad scale protection of property and beach/dune maintenance considered above, concern over stormwater drains discharging across Seven Mile Beach has been raised by members of the Community Reference Group. The drains discharge from points landward of the toe of the frontal dune and in the vicinity of the discharge point they tend to draw the toe of the dune landward of its natural alignment. This reduces the width of the frontal dune, and therefore its protective capacity in extreme storm events. In this regard the two northern-most drains in this beach unit (as shown in **Illustration 3.2**) are of particular concern.

Management Objective 2.1 of Precinct Plan 2 (refer **Section 3.4.9**) proposed the following actions:

- To prevent dune erosion, extend the storm water pipes to the natural dune line and install two stage gates at the following discharge points along Seven Mile Beach as shown on the locality plans.
  - Lennox Street
  - Williams Street
  - Ross Street
  - Foster Street

Investigation of the potential to extend the discharge point of these drains approximately 8-10m seaward of the current alignment of the toe of the dune is recommended. With the observed erosion trend, the toe of the dune is expected to move landward over time, therefore the pipe extension should, if possible, be modular to enable the location of the discharge point to be adjusted. This will also allow the outlet to be moved in response to any altered beach profiles resulting from beach nourishment should this be implemented in the future.

3.4.8 Development Control Plan

Chapter 17 of the Ballina Combined Development Control Plan, Coastal Hazard Protection, Lennox Head (Interim Measures) is the key planning document that relates specifically to mitigating risk from coastal erosion hazard in this beach unit, Lennox Head – north of Byron Street.

It is recommended that Council draft a new Chapter for the Ballina Combined Development Control Plan, to update and replace:

- Chapter 3 – Coastal Hazard Protection; and
- Chapter 17 – Coastal Hazard Protection, Lennox Head (Interim Measures).

The new Chapter would ideally have the following structure:

- Introduction
  - Aims, identification of land to which the chapter will apply, relevant definitions;
- Background to Coastal Hazards
  - Brief synopsis of the findings and recommendations of this CZMP, outlining Council's preferred approach to protect existing land by way of a terminal seawall and associated beach nourishment.
- Development Controls
  - Given Council's protection approach, there would be controls established:
    - seaward of the immediate hazard line (or seaward of the proposed seawall); and
    - landward of that line.
  - The chapter should indicate that Council will generally not support any new buildings or structures seaward of the immediate hazard line, other than public buildings / structures that might be necessary by their nature to be located within this zone (e.g. surf lifesaving observation structures, access structures, protective works, etc.).
  - Such development may be considered provided that any structures are easily removable or sacrificial and do not require any extension to service mains. In all cases, a Coastal Management Risk report, prepared by a suitably qualified professional, should be submitted with the application.
  - Controls on development landward of the immediate hazard line (or seawall) should be drafted to address the risk of inundation associated with overtopping of the seawall. Controls relating to footing / structural design and habitable floor levels are recommended.
  - For development located landward of the 2050 hazard line and seaward of the 2100 hazard line, applications for new development (or for significant renovations, alterations or additions to existing development) should be designed in accordance with the findings of a Coastal Risk Management Report, prepared by a suitably qualified professional.

- Information to be provided with applications
  - This section should clarify the scale and nature of information to be submitted with applications for development on land to which the Chapter applies. As indicated above, a Coastal Risk Management Report should be submitted with all applications. The level of detail to be provided with such a report should be established in this section, based on the level of risk presented by the development and its location.

3.4.9 Precinct Plan – Precinct 2

A number of the actions presented in *Precinct Plan – Precinct 2* will serve to mitigate coastal hazard threats and support public access in this beach unit. Many of these relate closely to the points outlined in **Section 3.4.6.3**. They include:

- Management Objective 1.10 – Surf Life Saving Requirements [in *Precinct Plan – Precinct 1*]
  - Consider future options for the Lennox Head – Alstonville SLSC site re expansion or relocation [note that the SLSC is under coastal hazard threat and relocation may be necessary in future]
- Management Objective 2.1 – Stormwater management
  - Extend storm water pipes to the natural dune line and install two stage gates at discharge points along Seven Mile Beach as per locality plans to prevent dune erosion.
    - Lennox Street
    - Williams Street
    - Ross Street
    - Foster Street
- Management Objective 2.3 – Pedestrian beach access (erosion control of dunes)
  - Re grass dune system in front of Lennox Head Hotel in stages, upgrading fencing.
  - Educate Pacific Parade residents to the value of short-term erosion control through native vegetation. Seminars, signage, printed material.
- Management Objective 2.7 – Vegetation management and environmental rehabilitation
  - Prepare and implement Vegetation Management / Landscape Plans for:
    - The dune system along Pacific Parade
  - Prioritise actions in vegetation management plans and encourage community to focus their activities on priorities
- Management Objective 2.8 – Vegetation management and environmental rehabilitation
  - BSC provides additional support to Care groups to protect and enhance native vegetation e.g.:
    - Develop Best Management Practices
    - Pro-active in helping groups increase membership through media releases & assisting with organising field days and events.
  - Promote sensitivity of dunes and impact caused by misuse via the local media, educational material and explanatory signage.
- Management Objective 2.10 – Erosion coastal hazard education
  - Encourage the community to provide input into future Coastal Hazard Plans for Precinct 2.
- Management Objective 2.11 – Beach erosion
  - Erect and maintain barriers to protect the fore-dune at the Boat Channel.
  - Stabilise pedestrian beach access points at the Boat Channel.

3.5 Lennox Head – South of Byron Street

3.5.1 Background and Objectives

This beach unit extends from the northern end of the rock revetment seawall near the intersection of Byron Street and Ballina Street to the southern end of Seven Mile Beach, as shown in **Illustration 3.2**. It receives considerable protection from wave action by the extensive natural nearshore reef structure of cobbles overlying indurated sand.

In response to historical erosion at Lennox Head south of Byron Street, the Lennox Head Beach Management Plan was implemented in 1993. It included the construction of rock revetment seawalls at the northern and southern ends of the beach unit with a constructed levee linking the seawalls, as well as various recreational amenity improvements and planning controls.

The seawall and levee works were implemented prior to recent amendments to the *Coastal Protection Act 1979* which require such works to be accompanied by actions that attempt to retain a beach seaward of the works where possible, i.e. beach nourishment. As a result, the current situation is such that when the beach profile is depleted of sand, public access along the beach in front of the northern seawall is not maintained at certain times depending on the tide and the actual level of sand depletion. In the absence of beach nourishment such access restrictions are likely to become more frequent and last for longer periods as discussed in **Section 3.4.2**.

This beach unit is subject to potentially severe wave attack during major storm events with large waves accompanying abnormally high storm tide levels. It is likely that, in the absence of beach nourishment, erosion will occur up to the seawalls and levee resulting in loss of the beach in front of these structures.

The broad management objective adopted for this beach unit is to protect development landward of the beach rather than remove development and allow erosion to proceed, i.e. protect rather than retreat. Ideally, the method of protection should provide for a natural beach and dune system that will act as a buffer to accommodate erosion seaward of the development during storm events and will be available for recreational and environmental purposes.

3.5.2 Management Plan

The existing seawall and levee, if appropriately monitored and maintained, are considered adequate to withstand a large coastal erosion event (or series of smaller events). Their structural adequacy will need to be monitored during and following coastal erosion events. Thus, theoretically, there is currently no coastal hazard threat to assets in this beach unit. However, the levee appears to have slumped in places from a design height of 5.5 mAHD to around 4.8 mAHD, mainly near access points, prompting **Management Actions 2014/1** and **2015/2**.

While no assets are expected to be under threat following implementation of management actions, the shoreline recession that is estimated for this beach unit will occur "against" the existing seawalls and levee, resulting in an on-going loss of beach amenity, as discussed in **Section 3.4.2.** Beach nourishment is to be carried out as part of the recommended management actions north of Byron Street and should extended into this beach unit to improve beach amenity and access in front of the seawalls and the constructed levee.

In response to Council's decision to protect rather than relocate assets, GeoLINK (2008) identified that the most effective strategy for this beach unit is the *Beach Nourishment with Seawall* option. That is, the *primary* recommended protection measure is beach nourishment to offset the long-term shoreline recession trend and thereby maintain the natural character of the beach and protect the assets landward of the beach. The seawall (including the levee) is currently in place and provides for a 'last line of defence'.

Beach nourishment in this beach unit may have adverse impacts on the ecological value of the nearshore rocky reef that extends along much of its length. Although the nearshore environment is one of substantial fluctuations and disturbances to which ecological communities adapt beach nourishment as recommended would be an unnaturally extreme change. The impacts would need to be considered in the EIS associated with any beach nourishment and may require the placement of less sand more frequently and/or the acceptance of lower levels of hazard mitigation and beach amenity that accrue from beach nourishment.

There is particular concern among members of the Community Reference Group regarding a stormwater drain discharging across the beach from a point that is landward of the toe of the frontal dune, as shown in **Illustration 3.2**. The effect of this discharge is to draw the toe of the dune landward of its natural alignment in the vicinity of the discharge point reducing the width of the frontal dune, and therefore the local protective capacity of the dune in the face of a large storm event.

Discussion of the following management actions recommended for this beach unit is provided in **Section 3.4**:

- Various monitoring actions discussed in **Section 3.4.3.2** and outlined in **Table 4.2**;
- Various dune management actions discussed in **Section 3.4.6.3** and outlined in **Table 4.3**;
- **Management Action 2014/1**. Conduct coastal engineering investigation to determine condition and adequacy of constructed levee to mitigate against hazards from design storm events and shoreline recession.
- **Management Action 2015/2**. Upgrade constructed levee on basis of investigation under **Management Action 2014/1**. Upgrade to include importation and stabilisation of additional sand to ensure that the crest elevation of the constructed levee is returned to the design level of RL 5.5 mAHD along its full length and maintained at that level.
- **Management Actions 2015/3** and **2016/1**. Investigate, re-design and install new stormwater drains discharging at the constructed levee. There may be an option to redirect the discharge at the base of the nearby seawall (note that this is considered in *Precinct Plan – Precinct 2*, see **Section 3.4.9**);
- **Management Actions ST3**. Carry out beach nourishment in conjunction with nourishment of the beach further north within ecological constraints associated with the adjacent reef areas to improve beach amenity and access.
- **Management Actions MT1 and MT2**. Monitor and maintain the structural integrity of the existing seawalls into the future;
- **Management Actions MT3**. Design and install boardwalk on existing seawall between Rayners Lane and Byron Street if public foreshore access is constrained too frequently.

3.5.3 Statutory Planning and Regulation

Chapter 3 of the Ballina Combined Development Control Plan, *Coastal Hazard Protection*, relates specifically to mitigating risk from coastal erosion hazard in this beach unit, Lennox Head – south of Byron Street. The material in this chapter is considered appropriate, however **Section 3.4.8**, recommends that it is combined with Chapter 17 (which relates largely to Lennox Head – North of Byron Street).

The regulations outlined in **Sections 3.4.6** and **3.4.6.2** should be applied to this beach unit.

3.5.4 Precinct Plan – Precinct 2

A number of the actions presented in *Precinct Plan – Precinct 2* will serve to mitigate coastal hazard threats and support public access in this beach unit. Precinct 2 includes two beach units considered under this CZMP, Lennox Head – North of Byron Street and this one, Lennox Head – South of Byron Street. The Precinct Plan actions relevant to this beach unit are outlined in **Section 3.4.9**.

3.6 Boulder Beach

3.6.1 Background and objectives

This beach unit extends between the cliffs at each end of Boulder Beach as shown in **Illustration 3.10**. Note that the aerial used for this illustration shows a large amount of sand accumulated on the beach – sand coverage of the underlying cobble field varies considerably over time.

WBM (2003) indicates a recession trend for this beach unit as shown in **Table 2.1.** However, it is estimated that the landward extent of beach erosion and shoreline recession will be limited by the cobbles that dominate the embayment (WBM, 2003). Consequently beach erosion and shoreline recession are likely to manifest in reduced coverage of the boulders both in terms of quantity of sand and frequency of coverage. If a rise in sea level of around 0.9 m is realised as advocated for use as a planning benchmark (DECCW, 2009) then it is possible some low lying areas behind the beach, which include a wetland area, will be inundated on high tides.

Despite the protection offered by the cobbles, there has been recent erosion in the southern corner of the beach from wave attack during high tides and storm events. There is speculation that removal of boulders some years previously may have contributed to exposure of the dune and subsequent erosion. The erosion is threatening a section of a popular walking track as well as adjoining remnant vegetation. It is expected that

the erosion will worsen in the short-term due to continued wave attack, and will be exacerbated in the medium-to-long term by shoreline recession.

Loss of any part of the track is expected to encourage pedestrians to create informal walking tracks leading to damage to surrounding remnant vegetation and leading to further erosion. In late 2011, Council began investigating the upgrade of the walking track under another program related to community recreational assets and recommendations from that investigation include rock revetment protection similar to that recommended here.

Source: Ballina Shire Council Date: December 2011

North

Boulder Beach - Management Actions

GeoLINK environmental management and design | BMT WBM 0766637

Coastal Zone Management Plan for the Ballina Shire Coastline

Illustration 3.10

3.6.2 Management Plan

There is no major development under coastal erosion threat in this beach unit (WBM, 2003). Consequently, the broad management objective for this beach unit is to allow coastal processes to proceed under monitoring, comprising photogrammetric monitoring of beach and foredune location and height as well as visual inspections on a regular basis. Recommended works are limited to those necessary to protect a short section of walking track as described below, and dune management works as required.

In relation to the threatened section of track, the *Precinct Plan – Precinct 3* makes a number of recommendations:

- Upgrade safety and stabilise the Boulder Beach to Iron Peg section of the foreshore track.
- Provide an alternative track from Iron Peg to Boulder Beach if the foreshore track becomes unsafe or impassable.
- Undertake a study to investigate long term options for protecting the existing track and maintaining the foreshore.

Due to the topography and vegetation around the threatened section of track, the only viable option for an alternative alignment (as part of the second action listed above) is around 20 m landward of the threatened section. This alignment is in close proximity to an area of littoral rainforest and Endangered Ecological Community. Members of the Community Reference Group have expressed a desire to minimise exposure of and access to this area, and do not support an alternative track landward of the current alignment. Additionally, given that the users of the track generally have a desire to be close to the shore, it is likely that uncontrolled access to and along the shoreline would still occur even with the provision of an alternative track landward of the current alignment. This will result in damage to vegetation, safety risks, and greater potential for erosion.

Therefore, it is strongly recommended that in front of the directly threatened section of track and the threatened Casuarina tree, the track on its existing alignment is stabilised by means of a placed boulder wall blending in with the natural surroundings. Behind the placed boulders a backing filter layer of smaller rock and gravel grading up to the larger armour rock should be installed to reduce the loss of sand through the structure during wave attack. Finally, a heavy duty geotextile fabric should be installed behind the smaller rock/gravel layer.

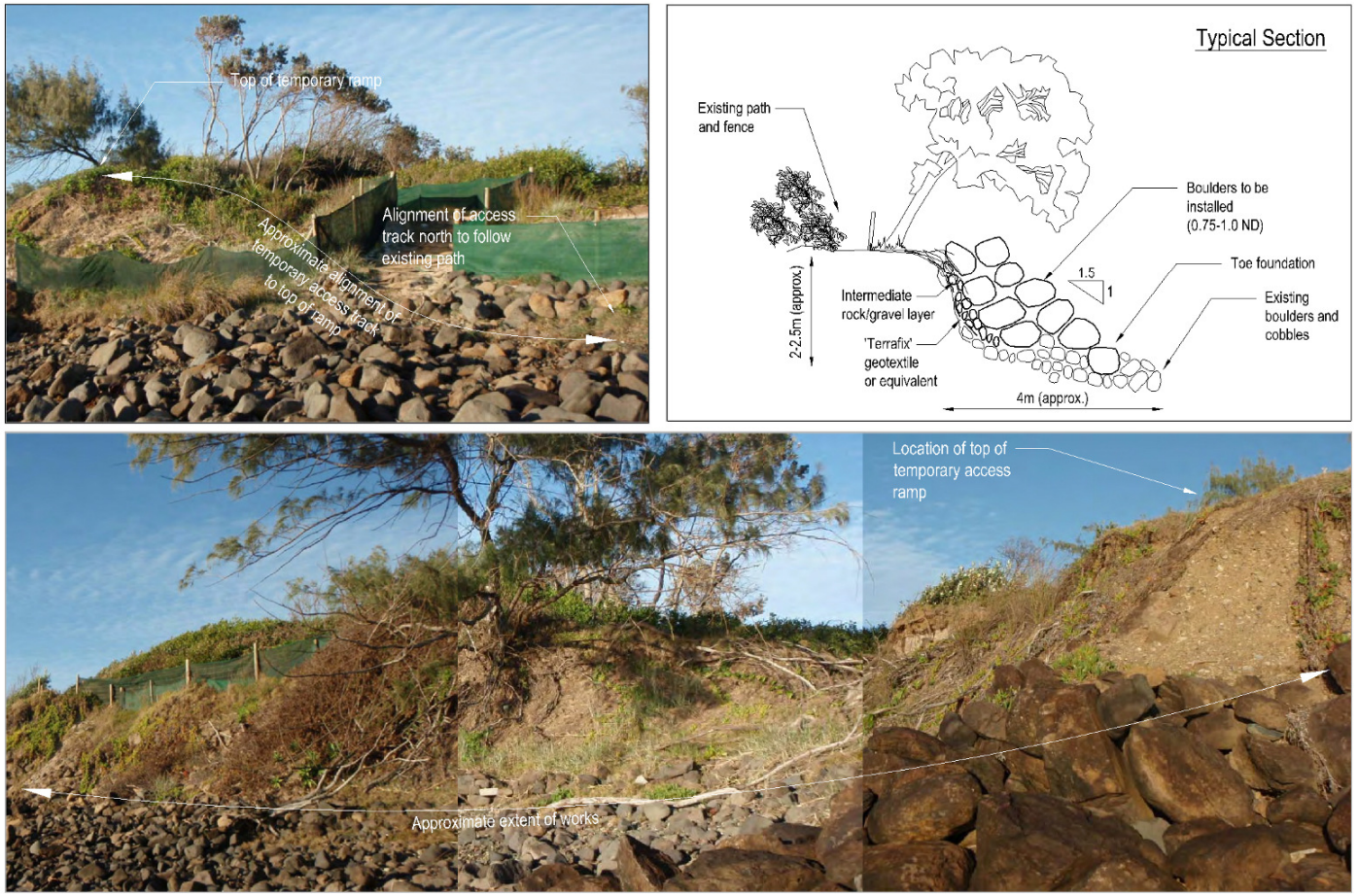
The large boulders should be basalt with a nominal diameter of 0.75-1.0m. Angular basalt boulders can be sourced from a number of nearby quarries, or opportunistically from major road works such as Pacific Highway upgrades. However it may be preferable to source rounded basalt boulders from farm clearing works to better match the shape of the existing boulders. The boulders should be placed against the erosion scarp as shown in **Illustration 3.11**.

The concept design for the recommended protection works is shown in **Illustration 3.11**.

Plant necessary for the placement of rock, such as 4WD loaders and excavators, may be able to access the works site from the seaward side if the boulder field seaward of it is covered sufficiently with sand. If the boulder field is exposed, or partially exposed, a temporary track may be required to provide access as the exposed boulder field will be damaging to and damaged by heavy plant.

Any temporary track should follow the existing pedestrian path south from the clearing until the stairs. Where the stairs deviate inland, the temporary track should continue over the slight rise seaward of the stairs and down a temporary ramp constructed from 200-300 mm cobbles at a slope of 1:3 (V:H). This ramp will lead directly to the area where the boulders are to be placed.

Source: GeoLINK Date: August 2008



0 NTS

Boulder Beach - Management Action Details

Coastal Zone Management Plan for the Ballina Shire Coastline

Illustration 3.11

The works will need to be monitored monthly over six months following installation to ensure that settlement has not destabilised the rocks and the 1:2 slope has been maintained. Following this initial period of settlement, the works should be inspected on a quarterly basis, and following large storm events, to assess general maintenance needs such as ensuring no boulders have become unstable and that sediment is not being entrained from behind the boulders and leading to erosion of the path. This monitoring is included under **Management Action M9**.

Construction activities associated with these works will prevent pedestrian access along the foreshore, with no apparent means of providing alternative access other than a temporary pedestrian path landward of the dunes. For reasons mentioned above, such a path is not favoured by members of the Community Reference Group, and therefore is not recommended. It is expected that pedestrian access will only be restricted for a maximum of six hours each day across low tide for approximately one to two weeks. Adequate forewarning of the inconvenience can be provided by means of temporary signage and public notices in the weeks leading up to the works.

In addition to protection works described above, it is recommended that Boulder Beach is included in the monitoring program that applies to the Ballina Pocket Beaches and South Ballina beaches, as described in **Section 3.7**.

3.6.3 Statutory Planning and Regulation

By virtue of clause 128 of *State Environmental Planning Policy (Infrastructure) 2007* the recommended works, being 'erosion control' and / or 'foreshore stabilisation works', are defined as 'waterway or foreshore management activities'. By virtue of clause 129 of the SEPP, these activities can be carried out by, or on behalf of a public authority on any land without the need for development consent.

However, environmental implications of the works must be considered in accordance with the requirements of Part 5 of the *Environmental Planning and Assessment Act, 1979*, through the preparation of a Review of Environmental Factors (REF). If the REF concludes that the works are likely to have a significant impact on the environment, an Environmental Impact Statement (EIS) would need to be prepared and publicly exhibited. Such a finding is, however, very unlikely.

While approvals under the *Coastal Protection Act* 1979, the *Crown Lands Act* 1989, the *Threatened Species and Conservation Act* 1995 and the *Fisheries Management Act* 1994 are not required for the recommended works, it will be the responsibility of the proponent, Council, to notify the relevant departments of the works and request advice on any measures that they may require.

The regulations outlined in **Sections 3.4.6** and **3.4.6.2** should be applied to this beach unit.

3.6.4 Precinct Plan – Precinct 3

Actions relating to coastal erosion presented in *Precinct Plan – Precinct 3* focus primarily on the track. They are outlined and discussed in **Section 3.7.3**.

3.7 Ballina Pocket Beaches and South Ballina beaches

3.7.1 Background and objectives

The Ballina pocket beaches comprise, from north to south, Boulder Beach which is considered separately in **Section 3.6**), and then Sharpes, Angels, Shelly and Lighthouse beaches, as shown in **Illustration 3.12**. The South Ballina beaches comprise, from north to south, South Ballina Beach, Beswicks Beach, Robins Beach and Patches Beach, as shown in **Illustration 3.13**. The estimated recession distances for these beaches are shown in **Table 2.1**.

As there is no major development under coastal erosion threat throughout all these beach units, and they exhibit general stability and low recession distances (WBM, 2003), the primary coastline management

objective is to allow coastal erosion to proceed under monitoring. In addition to the monitoring, localised dune management works are also recommended (**Section 3.7.2.1**).

Sharpes Beach, Flat Rock and Angels Beach

Sharpes Beach and Angels Beach are separated by a tombolo that joins the rocky platform, known as Flat Rock, to the mainland. The Coastline Hazard Definition Study highlighted that the alignments of Sharpes and Angels beaches are governed by the presence of the tombolo. Should the tombolo become detached from Flat Rock due to sea level rise or other influences, substantial erosion and realignment of both beaches is expected. However, there is no development under direct threat of such an erosion scenario although extensive areas of coastal heath will be lost. The nearest development, the Flat Rock Tent Park, is located well inland and is not under any immediate threat.

Analysis of aerial photographs taken in 1945 and 1971 suggests sandmining affected Sharpes and Angels beaches during that time (WBM, 2003). And recent shoreline evolution modelling and investigations presented at the 2009 NSW Coastal Conference indicate that the training walls of the Richmond River, built between 1890 and 1910, are likely to have reduced the supply of sand to the Sharpes and Angels beach units (D. Patterson, 2009). This effect is thought to now be reducing.

Despite these impacts, the beaches appear to have been relatively stable since 1974, and, provided the tombolo remains attached, this stability is expected to continue into the future (WBM, 2003). The tombolo does not appear to have been significantly affected by any sediment budget deficit which may have been operating on this beach unit. However sea level rise induced shoreline recession, which is expected to increase over the 2100 planning period, is likely to have some effect on the tombolo, but in the absence of detailed modelling the nature and extent of this effect cannot be determined.

The two beaches are likely to exhibit shifts in the balance of sand between one end of the beach to the other depending on prevailing wave direction as influenced by the Southern Oscillation Index. This is known as beach rotation and does not lead to a net loss of sand, but nor does it mitigate against coastal hazards in the long term.

Similar to Boulder Beach, the northern half of Sharpes Beach is backed and underlain by cobbles. The Sharpes Beach car parking area is immediately behind the northern end of the beach, and some rock armouring has been placed seaward of the car parking area. The cobbles and rock armour are expected to limit any coastal hazard threat to the car parking area. However, there is uncontrolled stormwater runoff and pedestrian access from the car parking area, causing localised scour and instability of the rock armouring. These issues are considered in the landscape plan that is proposed in *Precinct Plan – Precinct 3* that covers Sharpes Beach. The measures presented in the precinct plan, refer **Section 3.7.3** are considered sufficient to prevent coastal hazard threat.

In early 2012 Council put forward a development application for a major upgrade of the Sharpes Beach car parking area, including the provision of surf lifesaving and toilet facilities. In order to protect the proposed assets the application includes significant upgrade to the protective works, i.e. the rock armouring, currently in place.

Source: Ballina Shire Council Date: December 2011

Ballina Pocket Beaches - Management Actions

Coastal Zone Management Plan for the Ballina Shire Coastline Illustration 3.12

GeoLINK environmental management and design BMT WBM 0766637

Source: Ballina Shire Council Date: December 2011

North

0 NTS

South Ballina Beaches - Management Actions

GeoLINK environmental management and design BMT WBM 0766660

Coastal Zone Management Plan for the Ballina Shire Coastline

Illustration 3.13

The southern half of Sharpes Beach and all of Angels Beach have extensive dune systems and large areas of coastal heath landward of their beach alignments relative to other Ballina Pocket Beaches. Although there are no cobbles to limit erosion, these natural sand reserves and undeveloped areas constitute a substantial buffer to absorb coastal erosion and shoreline recession.

Shelly Beach

WBM (2003) indicates Shelly Beach is a relatively stable beach with some minor erosion of the main dune occurring between 1947 and 1974, and more recently in the lower sections of the beach. Similar to Sharpes and Angels beaches, Shelly Beach is thought to have been affected by the Richmond River training walls based on modelling by D. Paterson as described above.

In May 2009 Shelly Beach experienced significant beach erosion with some minor localised damage to a concrete path and erosion scarps reportedly up to 5 m in height. Accretion of the beach following the erosion was rapid and substantial.

Generally this beach is expected to remain stable into the future, with some beach rotation, and is likely to be subject to sea level rise induced shoreline recession. It may be more vulnerable to beach erosion than other pocket beaches.

Lighthouse Beach

Aerial photographs indicate Lighthouse Beach has steadily accreted since 1947, although the rate of accretion appears to have decreased recently. This accretion is thought to be due to the northern training wall of the Richmond River which defines the southern end of this beach. This beach is expected to remain stable into the future, with some beach rotation, and is likely to be subject to sea level rise induced shoreline recession.

South Ballina beaches

Accretion has been observed in the photogrammetric analysis of South Ballina Beach. This is thought to be due to realignment of the beach following the installation of the training walls and/or rebuilding of the dunes following previous wind drift losses, however WBM (2003) advocates a precautionary approach. This trend gradates to a low rate of observed recession at the southern end of Patches Beach (refer **Table 2.1**).

The coastline south of the Richmond River is primarily managed by:

- The Crown Lands Division of the NSW Department of Trade and Investment, Regional Infrastructure and Services; and
- The National Parks Wildlife Service of the Office of Environment and Heritage within the NSW Department of Premier and Cabinet.

However Ballina Shire Council has responsibility for 1.4 Ha parcel of land adjacent to the settlement of Patches Beach. For this parcel, Council has prepared a vegetation management plan that addresses a variety of issues including damage to dunes, weed infestation, erosion and predation by feral animals.

The Threatened Species (Pied Oystercatcher) Management Strategy (Department of Lands, 2007) aims to facilitate cooperative land management to minimise the impact of human activities on the Pied Oystercatcher within the area bounded by the Southern training wall of the Richmond River and the Black Rocks 4WD access track, which is beyond the Ballina Shire boundary.

3.7.2 Management Plan

There is no major development under coastal erosion threat in this beach unit (WBM, 2003). Consequently the broad management objective for these beach units is to allow coastal processes to proceed under monitoring, comprising photogrammetric monitoring of beach and foredune location and height as well as visual inspections a regular basis. Recommended works are limited to dune management works as required, with a focus on the Flat Rock tombolo.

The photogrammetric monitoring program, **Management Actions M2** and **M3**, would quantify the short and longer term beach changes taking place as an extension of the database of photogrammetry used in WBM (2003) providing accurate data for consideration of any future action. Photogrammetric analysis of aerial

photography on selected profile locations based on the profiles analysed previously for WBM (2003) should be undertaken as shown in **Illustration 3.14** and **Illustration 3.15**.

Because of the critical role of the Flat Rock tombolo in maintaining the current alignment of Sharpes and Angels beaches, it is recommended that particular attention be paid to the status of the beach and dune in this area as part of regular inspections (**Management Action M9**).

As a result of the significant erosion experienced by Shelly Beach in May 2009, despite the beach's rapid recovery, it is recommended that particular attention be paid to the status of this beach and dune system also. This may require an intensification of the photogrammetry sections proposed for Shelly Beach in **Illustration 3.14**.

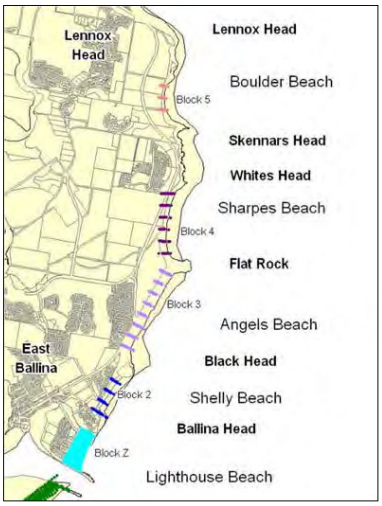


Illustration 3.14 Proposed Photogrammetry Sections – Ballina Pocket Beaches

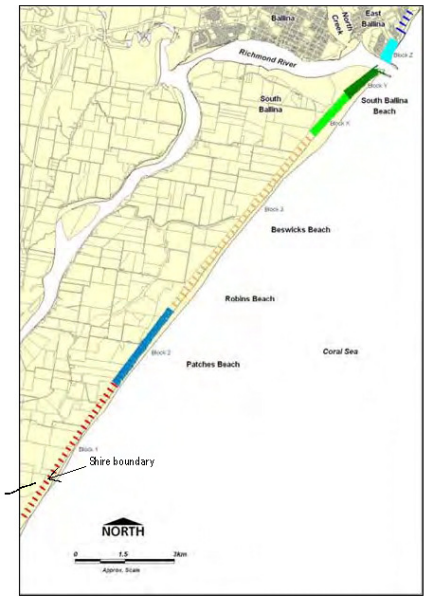


Illustration 3.15 Proposed Photogrammetry Sections – South Ballina beaches

The NSW Department of Environment Climate Change and Water provides aerial photography approximately every three years that is suitable for photogrammetric analysis. The professional services of the NSW state photogrammetry facilities would be suitable to undertake the analysis. It is expected that the photogrammetric analysis every three years will cost approximately $20,000. Should analysis costs be a substantial limiting factor, the photography should be obtained and archived for analysis at a later time when funding is available.

3.7.2.1 Dune Management Works

Maintenance or augmentation of dunes to maximise their natural protective role, both as a physical barrier and a source of sand during periods of erosion, is generally a cost-effective and ecologically sensitive means of managing small to moderate localised coastal erosion threats.

Native foredune vegetation, generally comprising grasses and vines, is fundamental to dune health by binding sand that is in already place or trapping aeolian sand following an erosion event. This effect can also be mimicked by the installation of dune fencing. Therefore dunes can be managed in various ways including:

- Conduct active regeneration (planting) in accordance with the *NSW Coastal Dune Management Manual* (DLWC, 2001);
- Install dune fencing in accordance with DLWC (2001);
- Remove invasive species and weeds;
- Manage pedestrian access in high traffic areas by installing signage, fencing and designated pathways; and
- Work with stakeholders to limit 4WD access to key locations and conduct compliance and enforcement activity to limit inappropriate access and damage due to irresponsible 4WD behaviour.

Council and numerous dedicated volunteer groups are already active in Ballina implementing such works, and in some cases have been instrumental in maintaining the health of dunes. It is recommended that Council maintain this program by continuing to allocate modest funding and resources (around $10,000 per site) for works in strategic locations, including

- Confirm the broad community benefit of allowing public 4WD access to the Flat Rock area and conduct frequent 4WD compliance and enforcement schedules where required;
- Maintain existing and expand sand capture and revegetation works at Flat Rock tombolo;
- Conduct sand capture and revegetation works and manage pedestrian traffic around the northern car parking area at Shelly Beach; and
- Continue sand capture and revegetation works around Patches Beach

3.7.3 Precinct Plans for Precincts 2, 3, 4 and 5

A number of the actions presented in the Precinct Plans for Precincts 2, 3, 4 and 5 will serve to address coastal erosion issues in this beach unit, many of which relate closely to the points outlined in **Section 3.7.2.1**. They include:

- Management Objective 3.3 – Off road vehicle beach access
  - Restrict 4WD beach access at Sharpes Beach to emergency vehicles and professional fisherman.
  - Maintain signage advising of vehicle beach access regulations at each access point.
  - Promote regulations in local media and promotional material.
  - Upgrade policing of regulations by increased and coordinated ranger presence.
  - Install locked gate as part of Coastal Reserve Master Key system as required (if drivers disregard regulations).
- Management Objective 4.3 –Vehicle access
  - Discourage off road vehicle access onto Sharpe's Beach and Angels Beach.
  - Annual review off beach access regulations. Change regulations based on complaints and identified impact of vehicles on recreation and natural amenity of beach.
  - If usage impacts on beach Council revokes policy of permitting vehicles on Angels Beach between sunset and sunrise.
- Management Objective 4.9 – Vegetation management
  - Impose heavy fines on any illegal clearing of native vegetation.
  - BSC provides additional resources to support community participation in native vegetation management works (e.g. supply materials such as mulch, herbicide, and fencing). Be proactive in providing training and assisting networking.
- Management Objective 4.10 – Vegetation management
  - Prioritise actions in the Angels Beach Vegetation Management Plan. Encourage community to implement highest priority actions.
  - Implement Angels Beach Vegetation Management Plan focusing on highest priorities
- Management Objective 4.15 – Habitat protection through education
  - Promote the environmental values of Precinct 4 by using the local media, publication and distribution of brochures, placement of signage etc. Continue to use the area for public education.
- Management Objective 5.3 – Environmental Management (Shelly Beach)
  - Review, prioritise actions and implement the Shelly Beach Vegetation Management Plan
  - Support Care groups as per action 5.4.
- Management Objective 5.4 – Environmental Management (Lighthouse Beach)
  - Upgrade, prioritise actions and implement the Lighthouse Beach Vegetation Management Plan
  - Support Care groups as per action 5.4.

4

Recommended Management Actions Summary

This section comprises the following tables:

- **Table 4.1** outlines the potential funding sources that may be available to fund the recommended actions. Each funding source is allocated a code that is used in **Table 4.1**, **Table 4.3** and **Table 4.4**;
- **Table 4.1** outlines recommended actions for monitoring that are generally ongoing with varying frequency. Each action is allocated a code for reference with **Section 3**;
- **Table 4.3** outlines recommended on-going works associated with foredune and beach access management. These actions relate to all beach units with allocation determined on the basis of needs and resource availability;
- **Table 4.4** outlines recommended long-term works broken down into financial years from 2012-13 to 2014-15, and then, as the timing of works becomes determined by trigger points (refer **Section 3.4.4.1**) into short-term (5-15 years), medium-term (15-25 years) and long-term (25+ years). Each action is allocated a code for reference with **Section 3** that comprises the recommended year of delivery with the priority for that year (e.g. priority 4 in financial year 2013-14 has a code of 2013/4).

Beach unit abbreviations used in **Table 4.1**, **Table 4.3** and **Table 4.4**.

- SMB Central and North Seven Mile Beach
- LHN Lennox Head, north of Byron Street
- LHS Lennox Head, south of Byron Street
- BB Boulder Beach
- BPB Ballina Pocket Beaches
- SBB South Ballina Beaches

Agency abbreviations used in **Table 4.1**, **Table 4.3** and **Table 4.4**.

- BSC Ballina Shire Council
- OEH Office of Environment and Heritage
- DPI Department of Primary Industries
- DSTA NSW Department of Services, Technology and Administration (Public Works)
- DSR NSW Department of Sport and Recreation
- LGSA Local Government and Shires Association

Cost estimate brackets used in **Table 4.1**, **Table 4.3** and **Table 4.4**.

- Op Included in Council's current operational budget
- 1 < $20,000
- 2 $20,000 to $50,000
- 3 $50,000 to $100,000
- 4 $100,000 to $300,000
- 5 More than $300,000

Table 4.1 Potential funding sources

Code	Source	Program	Activities	Type
Federal Government				
F1	Environment Australia via Northern Rivers CMA	Natural Heritage Trust	Dune management works (revegetation, strengthening, access management etc.) Major works may be funded if integrated with CMA Catchment Action Plan	Grant
State Government				
S1	Office of Environment and Heritage	Coastal Management Program	50% subsidy to Local Government for investigation, design and implementation of management measures and works to reduce potential damage from coastal processes in existing developed areas and for the conservation and/or improvement of beaches and public reserves. The priority for funding, however, is for the preparation of Coastal Zone Management Plans.	Grant
S2	Department of Lands	Crown Land Administration/ Management	Development and maintenance of the State's public reserves	Low interest loan
S3	Department of Planning	Coastal Lands Protection Scheme	Bring significant coastal lands (in terms of public access, scenic quality and/or ecological values) into public ownership and provide for their long term management and care.	Grant
S4	Department of Commerce	Natural Disaster Relief Program	Financial assistance for both emergency and restoration works of Council owned assets, other than those involving roads, bridges and Crown Lands.	Grant
Local Government				
L1	Ballina Shire Council	General rate revenue	Works	Rates
L2	Ballina Shire Council	Council loan funds	Works	Council
L3	Ballina Shire Council	Section 94 contributions	Land acquisition and improvement of amenities	Council
L4	Ballina Shire Council	Lease income from reserves	Works, land acquisition and improvement of amenities	Council
L5	Ballina Shire Council	Voluntary contributions	Works, land acquisition and improvement of amenities	Council
L6	Ballina Shire Council	Commercial venture involving coastal land	Works, land acquisition and improvement of amenities	Council/ commercial
L7	Ballina Shire Council	Special rate for area benefiting from works	Works	Rates
L8	Ballina Shire Council	Deferred payment scheme	Works	Loan funds
L9	Ballina Shire Council	Planning agreements	Works, land acquisition and improvement of amenities	Private, Council, commercial
Private				
P1	Private land owners	Private residents corporation	Works	Private

Table 4.2 Recommended Coastal Zone Management Actions – Monitoring

Code	Beach units	Recommended Coastal Zone Management Actions – Monitoring	Responsibility (lead in bold)	Performance measure	Frequency / timeframe	Cost bracket	Funding (Table 4.1)
M1	LHN LHS	Conduct aerial orthophoto pass and photogrammetric analysis. (Note: next aerial orthophoto passes currently expected in 2013, 2016 and 2019.)	**BSC**, OEH	Analysis complete	Approximately every 3 years. First analysis expected in 2013	1	S1, L1, L2, L4, L5, L6, L7, L8, L9
M2	SMB BB BPB	Conduct aerial orthophoto pass and photogrammetric analysis.	**BSC**, OEH	Analysis complete	Approximately every 6 years. First analysis expected in 2016 (including 2013 photo)	2	S1, L1, L2, L4, L5, L6, L7, L8, L9
M3	SBB	Conduct aerial orthophoto pass and photogrammetric analysis.	**BSC**, OEH	Analysis complete	Approximately every 9 years First analysis expected in 2019 (including 2013 and 2016 photos)	2	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9
M4	LHN	Conduct land-based surveys at locations 5, 6 and 7 (refer **Illustration 3.4**)	**BSC**	Surveys complete	Every six months for first 5 years, then annually, beginning 2012-13		
M5	All	Review historical data set of land-based and bathymetric surveys and determine value of developing on-going survey program to build on existing data. Based on results of existing data review develop survey program and modify **Management Actions M6** and **M7** accordingly.	**BSC**	Survey monitoring program developed	2012-13	1	S1, L1, L2, L4, L5, L6, L7, L8, L9
M6	LHN LHS	Conduct land-based surveys	**BSC**, OEH	Surveys conducted and recorded	Refer **Section 3.4.3.2**, ideally after major storms, 6 monthly for first 5 years, then annually	1 (per survey)	S1, L1, L2, L4, L5, L6, L7, L8, L9
M7	LHN LHS	Conduct bathymetric surveys	**BSC**, OEH	Surveys conducted and recorded	Refer **Section 3.4.3.2**	TBC	S1, L1, L2, L4, L5, L6, L7, L8, L9
M8	LHN	Conduct low cost beach monitoring at SLSC (refer **Appendix B**)	**BSC**, OEH	Data provided	Weekly to monthly depending on volunteer commitment / funding	1 (per year)	L1, L2, L4, L5, L6, L7, L8, L9
M9	All	Conduct visual inspection and compile photographic record (from set locations) of beaches, seawalls (LHN and LHS), dunes, levees and boardwalk (LHS). Concentrate on critical areas such as Lennox Head, Boulder Beach and Flat Rock tombolo.	**BSC**, OEH	Data collated, documented and reviewed	Annual and after major storms	1 (per inspection and report)	L1, L2, L4, L5, L6, L7, L8, L9
M10	All	Analyse all monitoring data and prepare detailed report including a review of currency of existing hazard zones and the need, if any, to have hazards recalculated.	**BSC**, OEH	Report prepared	After major storms, or every 6 years (first in 2016)	2 (per report)	L1, L2, L4, L5, L6, L7, L8, L9

Table 4.3 Recommended Coastal Zone Management Actions – Dune Management Works

Code	*Beach units*	*Recommended Coastal Zone Management Action – On-going Works*	*Responsibility (lead in bold)*	*Performance measure*	*Cost bracket*	*Funding (Table 4.1)*
DM1	All	Continue program to manage foredunes in line with Precinct Plans including the following broad actions: ▪ Conduct regular inspections (coordinated with Emergency Action Subplan) to confirm condition of dunes. ▪ Install and maintain sand capture fencing to complement the natural capacity of foredune vegetation in holding sand that is blown onto dunes, thereby increasing the sediment store and erosion mitigation capacity of dunes. ▪ Locate sand capture fencing based on regular inspection of condition of foredune and shift seaward if sufficiently 'full' or relocate entirely if toe of fore-dune is considered to be adequately seaward; and ▪ Revegetate foredune where practicable to increase rates of natural sand capture and the consolidating influence of root systems. ▪ Inspections and works should be focused on critical areas such as; o Between Byron and Foster streets; o Adjacent to stormwater outlets at Lennox Head village; o Adjacent to beach access points; and o Around the base of the Flat Rock tombolo.	**BSC**	**Program continued**	Op	L1, L2, L4, L5, L6, L7, L8, L9
DM2	All	Continue program to manage beach access points in line with all Precinct Plans including the following broad actions: ▪ Close informal beach access paths over dunes by fencing off, conducting revegetation and installing signage noting the revegetation site and directing people to the nearest formal beach access point. ▪ Monitor beach access points to ensure that any lowering of the foredune or damage to foredune vegetation associated with their installation and use does not occur to such an extent so as to exacerbate coastal hazard threat. ▪ Develop and implement a prioritised program of installing board-and-chain walkways and signage to identify and formalise appropriate beach access points throughout all beaches under Council management (i.e. north of the Richmond River) ▪ Following erosion events, remove sections of board-and-chain walkways that overhang scarps and/or conduct localised beach scraping to maintain suitable grades onto the main body of the beach. Reinstall necessary sections of walkways as the beach and foredune naturally accrete following the erosion event.	**BSC**	**Program continued**	Op	L1, L2, L4, L5, L6, L7, L8, L9

Table 4.4 Recommended Coastal Zone Management Actions – Protective Works and Associated Investigations

Year-priority	*Beach units*	*Recommended Coastal Zone Management Action – Long-Term Works*	*Responsibility (lead in bold)*	*Performance measure*	*Cost bracket*	*Funding (Table 4.1)*
2013-2014 Financial Year						
2013/1	LHN LHS	Investigate the feasibility of marine, estuarine and terrestrial sources of nourishment sand and the associated design of beach nourishment works. Investigation to include statutory planning and policy requirements, planning, comparing costs, and social and environmental impacts at source and destination locations.	**BSC**	Identification of suitable source. Design of beach nourishment works.	3	L1, L2, L4, L5, L6, L7, L8, L9
2013/2	BB	Conduct survey and investigations, prepare designs and obtain approval for protective works to prevent loss of walking track at the southern end of Boulder Beach.	**BSC**	Design complete Approval obtained	1	S1, S2, L1, L2, L4, L5, L6, L8
2013/3	All	Implement Precinct Plans	**BSC**	As per management actions in Precinct Plans	Various	Various
2014-15 Financial Year						
2014/1	LHS	Conduct coastal engineering investigation to determine condition and adequacy of the constructed levee to mitigate against hazards from design storm events and shoreline recession. Investigation to include survey of the levee to inform **Management Action 2015/2,** for returning the levee to a minimum design crest elevation of RL 5.5 mAHD.	**BSC**	Investigation complete and determination made	3	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9, P1
2014/2	LHN	Conduct coastal engineering investigation to determine alignment, condition and adequacy of existing buried seawall between Byron Street and the SLSC and Lake Ainsworth Sport and Recreation Centre. Investigation is to include survey of the dune to inform **Management Action ST2** to ensure the dune has a minimum crest elevation of RL 6.0 mAHD.	**BSC**, OEH, DSTA	Investigation complete and determination made	3	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9, P1
2014/3	BB	Install rock revetment, earth backfill and track works to prevent loss of walking track at southern end of Boulder Beach.	**BSC**	Works in place	3	S1, S2, L1, L2, L4, L5, L6, L8
2014/4	All	Implement Precinct Plans	**BSC**	As per management actions in Precinct Plans	Various	Various
2015-16 Financial Year						
2015/1	LHN LHS	Prepare design and EIS for beach nourishment on the basis of investigations initiated by **Management Action 2013/1**.	**BSC,** OEH	Design and EIS completed	4	S1, L1, L2, L4, L5, L6, L7, L8, L9
2015/2	LHS	Upgrade constructed levee on basis of investigation under Management Action **2014/1**. Upgrade to include importation and stabilisation of additional sand to ensure that the crest elevation of the constructed levee is returned to the design level of RL 5.5 mAHD along its full length and maintained at that level.	**BSC**, DECCW	Levee core upgraded as necessary Crest elevation of levee is RL 5.5 mAHD	3	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9, P1

Year-priority	*Beach units*	*Recommended Coastal Zone Management Action – Long-Term Works*	*Responsibility (lead in bold)*	*Performance measure*	*Cost bracket*	*Funding (Table 4.1)*
2015/3	LHN LHS	Investigate potential to redesign stormwater outlets to minimise adverse effects on foredune, in particular those discharging near ▪ Ross Street ▪ Williams Street ▪ Lennox Street ▪ Foster Street ▪ Rutherford Street ▪ The southern end of the constructed levee at the southern end of Seven Mile Beach	**BSC**	Investigations complete	2	L1, L2, L4, L5, L6, L7, L8, L9
2015/4	All	Implement Precinct Plans	**BSC**	As per management actions in Precinct Plans	Various	Various
2016-17 Financial Year						
2016/1	LHN LHS	Redesign and install new stormwater drains if investigation determines redesign is feasible. (Note: can be carried over to following years if investigation results in multiple and/or expensive redesigns.)	**BSC**	Works in place	3-4	L1, L2, L4, L5, L6, L8
2016/2	All	Implement Precinct Plans	**BSC**	As per management actions in Precinct Plans	Various	Various
Short-term (5-15 years)						
ST1	LHN LHS	Obtain approvals for beach nourishment program.	**BSC**	Approval obtained	2	S1, L1, L2, L4, L5, L6, L7, L8, L9
ST2	LHN	Following suitable beach erosion event, upgrade or reconstruct existing buried seawall, or install a new seawall between Byron Street and the SLSC and Lake Ainsworth Sport and Recreation Centre on the basis of investigations under **Management Action 2014/2**. Upgrade to include importation and stabilisation of additional sand to ensure that the crest elevation of the dune above the existing buried seawall is at or above RL 6.0 mAHD.	**BSC**, OEH, DSTA, DSR	Seawall upgraded as necessary Dune crest is RL 6.0 mAHD	5	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9, P1
ST3	LHN LHS	Implement beach nourishment program coordinated with seawall works.	**BSC**, OEH	Beach nourishment conducted	5	Special state and Federal funding
Mid-term (15-25 years)						
MT1	LHN LHS	Conduct detailed investigations to ensure continuing adequacy of protective measures.	**BSC**, OEH	Investigations complete	2	
MT2	LHN LHS	Implement maintenance measures of dunes, seawalls and levee as required on basis of monitoring program	**BSC**, OEH	Implemented as required	2-3	L1, L2, L4, L5, L6, L7, L8, L9

Year-priority	*Beach units*	*Recommended Coastal Zone Management Action – Long-Term Works*	*Responsibility (lead in bold)*	*Performance measure*	*Cost bracket*	*Funding (Table 4.1)*
MT3	LHS	Design and install boardwalk on existing seawall between Rayners Lane and Byron Street if public foreshore access is constrained too frequently.	**BSC**	Boardwalk installed	4	State and Federal funding L1, L2, L4, L5, L6, L7, L8, L9
Long-term (25+ years)						
LT1	LHN LHS	Conduct re-nourishment of beach as necessary (if possible)	**BSC**	Re-nourishment conducted in a timely fashion	Variable	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9 P1

Project Team

The project team members included:

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Appendix A

Plates

Plate A.1 Cobble field at Boulder Beach. (exposed following January 2008 storms). View south (left) and north (right) from immediately seaward of clearing at end of access track, taken at mid to high tide.

Plate A.2 Cobble field at Sharpes Beach (exposed following January 2008 storms). View south (left) and north (right) from immediately seaward of car parking area, taken at mid to high tide.

Plate A.3 Sand capture fencing on Seven Mile Beach dunes immediately north of Byron Street.

Appendix B

Beach and Surf Measurements - A Simple and Low-Cost Method

By Dean Patterson

B.1 Introduction

A simple method for reliable measurement of wave heights and longshore sand transport was derived by the writer during the 1980s. It was used for many years by the (then) Beach Protection Authority of Queensland as the basis for its volunteer beach observation program (COPE) at locations along the Queensland coast.

Calculation of the rate of sand transport along the beach at a given time can be expressed as a simple relationship derived from theory as:

$S = 1860\ H^2.\ V$ (m^3/day)

Where
S = Longshore sand transport rate per day
H = Wave breaker height (m)
V = Average longshore current speed (m/s)
The constant (1860) has been calibrated to Gold Coast COPE data where the annual average net transport is about 500,000 m^3/yr. It corresponds well with conventional CERC equation values.

It is necessary then to estimate H and V to calculate S.

B.2 Measurement Method

B.2.1 Wave Height (H)

Measurement of the breaker wave height is based on the principle that looking at the horizon gives a very close horizontal line of sight. Thus, standing at the beach with eye level such that the crest of the wave as it first breaks lines up with the horizon will place eye level at the height of the wave crest above sea level.

By standing in the wave swash at a location that is close to mean sea level at the time, a direct measurement of the wave crest height (a_c) can be made with a graduated measuring pole (see **Illustration B1**). If the waves are too high to view the crest from the swash area, then the pole needs to be located at mean sea level and the observation made from further back, as shown in **Illustration B1**. To do this, someone else has to hold the pole or it needs to be pushed firmly into the sand with its zero at mean sea level.

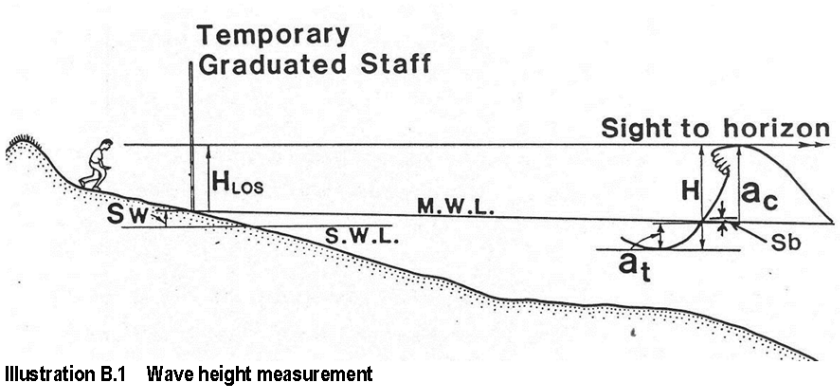


Illustration B.1 Wave height measurement

This measured wave crest height does not include the wave trough (a_t) that extends below mean sea level, or the slight setup of the water level at the beach (S_w). It is thus less than the total wave height. It has been shown that the wave crest height as measured by this line of sight method (HLOS) is about 0.7H.

However, the waves will vary in height at a given place over time and also spatially as the observer looks at different places along the beach at a given time. It is necessary to get an average wave height by following the measurement procedure for about 5 minutes and averaging the crest heights measured. Alternatively, it has been found that the average is about 0.65 times the maximum wave crest height measured over about 5 minutes.

Therefore, we can adopt as the mean value of the trough to crest wave height H:

$H = (0.65\ H_{max})/0.7 = 0.93\ H_{max}$

This wave height has been shown to correspond reasonably closely with the breaking significant wave height.

B.2.2 Longshore Current (V)

The longshore current needed is the movement of water along the shore in the surf zone between the wave break point and the beach. It can be measured by throwing a suitable float into the surf zone and measuring how far it travels along the beach in a given time. The float needs to be one that is a bit submerged so it doesn't wash too quickly back to the beach in the waves.

A float can be made from a piece of hardwood or a plastic pipe partly filled with sand and with the ends blocked. It needs to be of a shape and size that can be thrown far enough into the surf zone to measure the average current. Some have even been cast using a fishing rod where the surf zone is very wide.

It is OK to throw the float to the outer part of the surf zone and let it wash back across the surf zone over a few minutes.

Measure the distance along the beach (D metres) in one minute and get the current as:

V = D/60 (m/s)

Note that there are sometimes rips that would carry the float out to sea. These should be avoided. Also, it helps to retrieve the float by attaching it to a hand held fishing line. The line actually helps a little in getting the average current.

B.2.3 Longshore Sand Transport (S)

By taking the measurements every day and using the formula for S (which gives cubic metres per day), the amount of sand being transported along the beach can be accumulated over time. The seasonal patterns can be identified, as can the rate per year. Each year will be a bit different, so really useful results need to be extended over a number of years.

If the measurements are made only once per week, then the formula for S needs to be multiplied by 7 to determine the transport rate for the week. However, this is not as accurate because it will not identify the variability during the week when the measurements are not being made. It has been found that a large proportion of the sand transport can occur in just a few days when the waves are high and the current strong. Missing those days will cause a significant error in the total rate for the year.

Appendix C

Community Reference Group Terms of Reference

Aims

- To provide a forum for discussion and exchange of information on topics related to the preparation of the Ballina Shire Coastline Management Study and Management Plan.
- To assist the Ballina Shire Council to identify issues related to the preparation of the Ballina Shire Coastline Management Study and Management Plan.
- To act as a feedback mechanism between stakeholders and the Ballina Shire Council.
- To provide recommendations to the Ballina Shire Council Group Manager, Civil Services for analysis and report to Council.

Terms of Reference

The functions of the Ballina Shire Coastline Management Study and Management Plan Community Reference Group and its technical advisers are to:

- Meet regularly as required to provide input on the project.
- Represent the needs and interests of members or member groups as well as considering the needs and interests of other stakeholders within the broader community.
- Identify any emerging issues related to the project.
- Consider technical reports and other information related to the project that are provided by Ballina Shire Council, its technical advisers and its members or member groups.
- Assist the Ballina Shire Council in its endeavours to maintain an appropriate community consultation program during ongoing development and implementation of the various components of the project.
- Assist Ballina Shire Council to maintain an adequate record during the project development and implementation process and make the record publicly accessible.
- The group will report to the Manager of Council's Civil Services Group.

Role of the Community Reference Group

The role of the Community Reference Group is consultative. The group will share ideas and information in order to assist Council in the formulation of the Ballina Shire Coastline Management Study and Management Plan. All contributions from the group will be considered in light of the objectives of the project and statutory and policy requirements.

Community Reference Group Membership

Invitations for membership of the Community Reference Group will be forwarded by Ballina Shire Council. Additional requests for membership will be required in writing to the General Manager, Ballina Shire Council.

Nominees may represent local organisations, government agencies and interest groups, but individuals may also nominate.

The Community Reference Group will include technical staff from the project team. Ballina Shire Council may identify the need for additional input from other stakeholder groups. Ballina Shire Council may arrange for additional invitations for membership or may arrange for guests to provide specialist advice from time to time.

Appendix D

Community Information Flyers

Ballina Shire Coastline Management Study and Management Plan

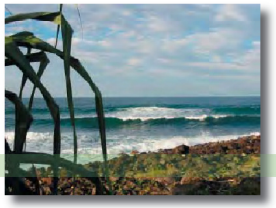
COMMUNITY PARTICIPATION

Community participation will be an important part of the development of both the Coastline Management Study and the Coastline Management Plan.

Stage 1 – Coastline Management Study – Values and Issues Assessment
Before management objectives and options to reach those objectives can be set, the project team needs a good understanding of the issues and values held by the community regarding the Ballina coastline. These issues and values are likely to be ecological, aesthetic, cultural, recreational, social and economic in nature.

Stage 2 Coastline Management Study – Management Objectives and Options Assessment
The Coastline Management Study will set out management objectives, and options to meet those objectives, in response to the coastal hazards (identified in the Hazard Definition Study), the community issues and values (identified in Stage 1 above), and the NSW Coastal Policy.

Stage 3 – Coastline Management Plan
This plan will result from the prioritisation of management options and the adoption of those most preferred in achieving the management objectives and resolving the identified issues.



HOW TO GET INVOLVED

A series of open days and workshops will be held as part of each of the stages listed above. Ballina Council has initiated a Community Reference Group to assist with this coastline management project, however, the open days and workshops will ensure the whole community has the opportunity to participate in the development of the plan.

Further project information can also be accessed via Ballina Shire Council's website at www.ballina.nsw.gov.au

If you would like to be informed directly of opportunities to contribute, or you already have some comments or ideas about the coastline of Ballina Shire, please get in touch with the project team via the following details.

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WBM OCEANICS AUSTRALIA

GeoLINK environmental management and design

Ballina Shire Coastline Management Study and Management Plan

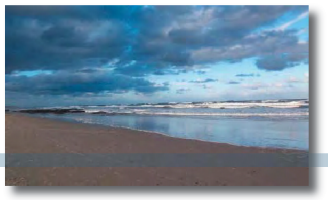
NSW Government
DEPARTMENT OF NATURAL RESOURCES

ballina

INTRODUCTION

Ballina Shire Council is developing a Coastline Management Plan, and welcomes community participation in the process.

The plan needs to consider coastal hazards such as erosion and storms, balance short-term priorities with long-term actions, and accommodate the full range of social, economic, recreational, ecological and aesthetic values held by the community.



OUTLINE OF THE PLAN

The Ballina Coastline Management Plan, when developed, will make provision for:

- Protecting and preserving beach environments and beach amenity;
- Emergency actions during periods of coastal storms and beach erosion;
- Managing longer term erosion threats; and
- Ensuring continuing public access to beaches and headlands, particularly where public access is threatened.

The plan must respond to the issues raised in the recently completed Ballina Coastline Hazard Definition Study. This study has highlighted coastal erosion threats, both short-term beach erosion and longer-term shoreline recession.

Work with us on the future of our coast

Mayor, Councillor Phil Silver

"We have a wonderful stretch of coastline in the Ballina Shire, and we want to make sure it is protected into the future. Our coast has a wealth of assets and is used, not only by Ballina Shire residents, but also by visitors from far and wide. The combination of increasing pressure associated with a growing population and the ever-present threats associated with erosion and storm activity mean we cannot sit back and take our coastline for granted."

"Council is working with the State Government, under the framework of the NSW Coastal Policy, to ensure that our coastline remains a valuable asset for all future generations. Consultants, GeoLINK and WBM Oceanics, will continue the work started by Council to produce a Management Plan that balances short and long term actions and deals with the issues of continued use and protection of our coastline."

BACKGROUND

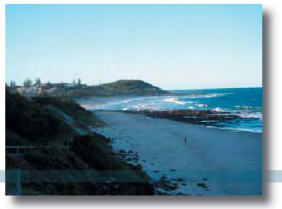
Ongoing concern regarding coastal erosion threats to property and infrastructure in the Shire has prompted various coastal erosion investigations and structural works. This has included a Beach Management Plan for Lennox Head.

In 1999, Ballina Shire Council commenced a program, advocated by the NSW Coastal Policy, to formalise management of the Shire's coastline. To date, this has included:

Ballina Coastline Hazard Definition Study – Completed by WBM Oceanics in 2003, this study describes the Shire's prevailing coastal processes and coastal hazards, and will directly inform the Ballina Coastline Management Plan.

Ballina Coastline Interim Measures and Action Plan – This interim plan was completed in 2005 and deals with threats to development and emergency responses in regard to immediate coastal hazards (e.g. severe storms) and will guide Council with development applications in the erosion hazard zones until the final Coastline Management Plan is implemented. Development Control Plan No. 17, Coastal Hazard Protection, Lennox Head resulted from this study.

The Ballina Coastal Reserve Plan of Management – This plan was finalised in 2003 and rationalises all Crown Lands and Crown Reserves into a single Coastal Crown Reserve for the purpose of Public Recreation and Coastal Environmental Protection.



THE DEVELOPMENT OF A COASTLINE MANAGEMENT PLAN

Development of the Ballina Coastline Management Plan will be guided by the Coastline Management Manual, established under the NSW Coastal Policy. This process ensures social, economic, recreational, aesthetic and ecological issues are considered along with coastal hazards.

Ballina Council has completed the first two steps required by the manual, namely the establishment of a Coastline Management Committee (this has been superseded with a Community Reference Group) and the preparation of a Hazard Definition Study (described above).

The next step is to prepare a Coastline Management Study. This study will establish management objectives and consider all the feasible options to meet those objectives, with regard to social, economic, recreational, aesthetic and ecological issues and coastal hazards.

The Coastline Management Plan then defines the best combination of options outlined in the study in order to achieve the objectives.

A draft of the Coastline Management Plan will be available for public comment before it is submitted to the Minister for Natural Resources for approval and gazettal, and the actions begin to be implemented

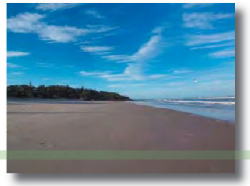
Aerial image source: Plateau Images. Note: indicative map only.

THE STUDY AREA

The study area extends from the boundary with Byron Shire Council at the northern end of Seven Mile Beach, to the boundary with Richmond Valley Council near Boundary Creek, south of Patches Beach. It includes the beaches of Seven Mile, Boulder, Sharps, Angels, Shelly and Lighthouse north of the Richmond River and South Ballina, Beswicks, Robins and Patches Beaches south of the river. It includes the headlands, bluffs and adjacent rocky shores and rock platforms of Lennox Headland, Iron Peg, Skennars Head, Black Head and Ballina Head.

This study area includes the southern part of the Cape Byron Marine Park, from the Ballina-Byron Shire boundary to Lennox Head.

The width of the study area is variable, and includes both marine and terrestrial areas around the shoreline. The terrestrial area may extend beyond the influence of coastal hazards and features such as beaches, dunes, headlands, marine derived water bodies and their surrounds to include lands within which existing or proposed human activities may impact on the shoreline or its immediate environment. Similarly, while the marine area is not subject to Council's planning control, it is important to consider marine processes, submerged lands and existing and proposed human activities that may impact on the shoreline and its immediate environment.



Ballina Shire Coastline Management Study and Management Plan

Newsletter No.2 November 2006

NSW Government
DEPARTMENT OF NATURAL RESOURCES

INTRODUCTION

Ballina Shire Council is preparing a Coastline Management Plan that will apply to the entire shire coastline. The plan will:

- consider coastal hazards such as erosion and storms;
- balance short-term priorities with long-term actions; and
- address the full range of social, economic, recreational, ecological and aesthetic values held by the community.

This is the second newsletter in a series that will keep residents of Ballina Shire informed of the development of the plan. The first newsletter, and further information about the plan, is available on Council's website http://www.ballina.nsw.gov.au/cmst/ballina003/nova.asp (look under 'environment' on the left-hand side of the homepage).

VALUES ASSESSMENT

One of the initial tasks in preparing the Coastline Management Plan is to identify the 'values' held by the community in relation to Ballina Shire's coastline. The term 'values' is very broad and includes:

- maintenance of the 'character' of certain areas;
- protection or improvement of the natural environment;
- ensuring public safety;
- provision of recreational amenity;
- protecting Aboriginal and European heritage;
- controlling access to minimise environmental impact; and
- sharing coastal areas appropriately among all users.

Ballina Shire Council has developed a series of DRAFT Precinct Plans as part of the Ballina Shire Coastal Reserves Plan of Management. These plans tailor the management of parts of the coastline to the needs of the community and the environment (i.e. the values) identified for that specific area.

Many members of the community have already contributed a great deal of their time highlighting values to Ballina Shire Council through the Precinct Plans process. The information provided overleaf includes very brief summaries of the values expressed by the community for each precinct.

NEXT STEPS

Once all of the community's values have been identified, they will be considered in relation to the coastal erosion hazard issues that were identified by WBM in the Ballina Coastline Hazard Definition Study (available on the Ballina Shire Council website). This will lead into the next stage of the Coastline Management Study where management objectives will be identified for the values / issues, based on our understanding of coastal hazards.

COMMUNITY INPUT

What do you think? Do the values outlined **overleaf** include your concerns and ideas? To ensure that the Coastline Management Plan is representative of the whole community, anyone who has concerns or ideas about the Ballina coastline should get in touch with the project team via the details below.

Also, the project team will be available to **meet with the public** and discuss the plan between **9am and 12pm** on **Saturday 18 November** near the pedestrian traffic lights on River Street in Ballina.

A Community Reference Group, made up of a broad range of community members involved in the coast, is providing community input into the project, however, it is important that everyone has an opportunity to contribute. Please take the time to talk to the Project Team on 18 November or send us your thoughts.

GET INVOLVED

If you would like to contribute to the management of Ballina's coastline, please contact the project team.

Rob van Iersel, Project Manager
T 6687 7666 (GeoLINK)
F 6687 7782 (GeoLINK)
E coastlinemanagement@geolink.net.au

Ballina Coastline Management Plan
PO Box 9, Lennox Head,
NSW 2478

SUMMARY OF VALUES IDENTIFIED IN THE BALLINA SHIRE COASTAL RESERVES PRECINCT PLANNING PROCESS

South Ballina Beach and Patches Beach

South Ballina Beach and Patches Beach were not considered under the precinct planning process. The Department of Lands is currently finalising the *Pied Oyster Catcher Threatend Species Management Strategy* for this important area of the bird's habitat. This process has identified a number values including 4WD access, horse riding and pipi gathering. Please get in touch with the project team to express your values for this part of the coast.

PROJECT CONSULTANTS

WBM OCEANICS AUSTRALIA

GeoLINK environmental management and design

Precinct One

- Retain the remote character of the area.
- Control use of the beach by dogs, horses, 4WD vehicles, and commercial activities.
- Implement dune stabilisation and revegetation works.
- Recognise and promote importance of Aboriginal heritage in the area.

Precinct Two

- Protect beach and dunes from stormwater erosion in front of Lennox Head village.
- Protect dunes and vegetation with rehabilitation, community education, and access control.
- Rehabilitate degraded tracks on Lennox Headland.
- Enforce prohibition of dogs and horses on all Precinct 2 beaches.
- Provide improved parking facilities at Lennox Point Surf Break carpark, Pat Morton Lookout and along Pacific Parade.

Precinct Three

- Protect beach from stormwater erosion, particularly at north end of Sharpes Beach around The Coast Road pedestrian underpass.
- Protect native vegetation and control erosion along foreshore paths.
- Formalise pedestrian access, and control 4WD access, to Sharpes Beach.
- Upgrade surf-life saving and public amenity facilities at Sharpes Beach.
- Improve traffic safety at entrances to car parks.

Precinct Four

- Construct interpretive trails radiating from Flat Rock Tent Park, to the sand 'Knoll' to the west and to the wetland area to the south.
- Up-grade parking and traffic facilities at Angels Beach and Black Head rock platform.
- Prepare locality plans identifying amenities up-grades at Black Head, Angels Beach and Flat Rock.
- Control erosion of tracks.
- Conserve native vegetation.
- Regulate dogs, horses, 'off road' and commercial activities in the precinct.

Precinct Five

- Ensure good water quality and access in Shaws Bay.
- Rationalise and formalise pedestrian beach access paths.
- Develop and implement detailed plans for facilities at Shaws Bay, Pop Denison Park, Shelly Beach and South east Finger Shaws Bay.
- Enforce issues relating to off-road vehicles, dogs, horses and commercial activity.

UPR 766580

Ballina Shire Coastline Management Study and Management Plan

Newsletter No. 3 May 2008

Council is seeking your input on the future of our coast

Introduction

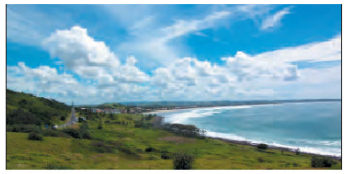
Ballina Shire Council is working with the NSW State Government to develop a management plan that will ensure the Ballina coastline continues to provide the ecological, cultural, recreational and economic benefits residents and visitors currently enjoy. The project has reached a point where Council is now seeking the community's view in relation to the Ballina Coastline Management Study, and you are encouraged to provide comment.

Mayor's Foreword
Mayor, Councillor Phillip Silver

Ballina's coastline is a vital part of the culture, identity and economy of this area – residents enjoy it every day, and each year thousands of visitors are attracted to the area to experience our coastline. Our challenge is to manage threats to our coast in a way that will maximise the benefits for the whole community. Please do your part to ensure future generations will continue to enjoy our beaches and foreshores by having your say on the future management of our wonderful coastline. Please comment during the exhibition period.

Coastline Values

Ballina Shire Council has been working with consultants GeoLINK and BMT WBM, and community representatives, on the preparation of the Ballina Coastline Management Study. Part one of the study, the Values Assessment, identifies the ecological, cultural, heritage, recreational, and economic values of the Ballina coastline. It answers the question – what aspects of the coast are important to the community and for what reasons?



Coastline Erosion

The Ballina Coastline Hazard Definition Study (WBM, 2003) found that the Ballina coast is subject to three forms of erosion:

- Short term storm erosion (associated with major storm events, sometimes called 'storm bite');
- Long term erosion (associated with differences in the amount of sand entering and leaving beach 'compartments' as it moves northwards along this stretch of coast), and
- Climate change shoreline recession (associated with water encroaching inland as sea levels rise).

These processes occur naturally on most coastlines and only become problematic when they threaten coastal values, generally as a result of development near the coast.

Please turn over

Department of Environment & Climate Change NSW

ballina

Please turn over

Coastline Management Options

Part two of the Ballina Coastline Management Study, the Management Options Assessment, identifies where coastline values may be under threat from coastline erosion. It outlines the various means (e.g. seawalls, beach nourishment etc.) by which these erosion threats might be managed in order to protect values and suggests a preferred approach for each of Ballina Shire's beaches.

Community Consultation

Council recognises the coastline is important to the whole community for many different reasons. Therefore, the Ballina Coastline Management Study (Part One and Part Two) is on public exhibition between Thursday 29 May and Friday 27 June 2008. During this time Council's consultants, GeoLINK and BMT WBM, will be available at a Community Open Day in Lennox Head to discuss the management study and the project.

Coastline Management Plan

The Ballina Coastline Management Plan will be prepared following the exhibition of the management study. The management plan will draw on advice from the community, Ballina Shire Council and the NSW Government, as well as feedback from the exhibition of the Ballina Coastline Management Study. It will present a strategic plan for the implementation and funding the preferred management options for each beach in Balina Shire. This plan will also be publicly exhibited, but now is the ideal time to have your say about the Ballina Coastline Management Study which underpins future work on the project.

GeoLINK environmental management and design

BMT WBM

Have your say

Review documents

All key documents are available on-line at www.ballina.nsw.gov.au (search for 'Coastline Management') and hard copies are available at Council's Community Access Points.

Community Open Day

GeoLINK and BMT WBM will be hosting a Community Open Day in Lennox Head on Saturday 14 June 2008 between 9am and 1pm at the Lennox Boulevard (near the newsagency). Interested members of the community are encouraged to attend.

Contact the project team

You can provide comments and advice at the Community Open Day or directly to GeoLINK via telephone: 6687 5807, email: coastlinemanagement @geolink.net.au post: PO Box 9, Lennox Head, NSW, 2478.

Ballina Shire Coastline Management Study and Management Plan

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Our Ref: L.B18741.001.Stage 1.doc

21 October 2011

Ballina Shire Council
PO Box 450
BALLINA NSW 2478

Attention: Paul Busmanis

Dear Paul

RE: Updated Coastal Hazard Areas for Ballina Shire: Stage 1 – Preliminary Update

Stage 1 of the coastal hazard areas update for Ballina Shire has been completed. The following letter report:

- Outlines the methodology used during the assessment
- Summarises the assessment results; and
- Provides revised hazard area maps for the priority township area of Lennox Head.

1 Introduction

The Ballina Shire Council has resolved to update its Coastal Hazard Area assessment as part of finalising a Coastal Zone Management Plan for the Shire. The Plan is being developed to address risks from coastal hazards; community uses of the coastal zone and pressures on coastal ecosystems including projected sea level rise.

The task of planning for future development and maintaining the existing natural environment within Ballina Shire is complicated by existing and projected coastal hazards. A Coastline Hazard Definition Study was completed by WBM Oceanics Australia in 2003. At that time, the projected rise in sea level over 50 and 100 years as a result of the Greenhouse Effect was adopted as 0.2 and 0.5m respectively. There are now more recent projections of sea level rise for these planning periods with higher values, which impact on the widths of the assessed coastal hazard zones. In addition, there is now a further 10 years of historical data which could be used to inform an updated analysis of the hazard areas.

This letter report sets out the methodology and results of a preliminary update of hazard areas for the Shire using readily available information. These assessment results supersede those previously reported in the Coastline Hazard Definition Study (WBM Oceanics Australia, 2003) to inform the Coastal Zone Management Plan (CZMP) which is in preparation. It is recommended that a more detailed revision of the coastal hazard areas be undertaken when further historical photogrammetry data and possibly other beach and offshore data become available.

2 Methodology and Results

Revision of the coastal hazard zones for the southern section of Seven Mile Beach, adjacent to the township of Lennox Head has been completed following:

- Definition of existing beach conditions using the most recent available photogrammetry (January, 2010);
- Reassessment of the current (immediate) hazard line based on the most recent photogrammetry (January, 2010) and an assumed design storm bite volume of 200 m^3/m; and
- Revision of long term shoreline recession estimates accounting for updated projected climate change related sea level rise allowances.

The estimates of shoreline recession associated with the updated sea level rise allowances projected for climate change apply to the other beaches of the Shire as well. For this preliminary update, a revision of the general long term recession rates based on an extended data base of historical shoreline movements and reassessment of the processes has not been undertaken.

2.1 Existing Beach Conditions

Definition of the existing beach conditions has been assessed for Lennox Head using the most recent photogrammetry (January, 2010). While photography has been captured for other beach areas (and other dates), this is the only photogrammetry data readily available at present. As outlined below, it is evident that the beach at Lennox Head has accreted since the assessments undertaken for the previous 2003 report. These existing conditions have been used as the base for the determination of hazard areas at Lennox Head.

2.2 Immediate Hazard Line

The immediate hazard line represents the short term storm bite demand with no allowances for long term recession or sea level rise.

The immediate hazard line for the southern end of Seven Mile Beach at Lennox Head has been assessed using the 2010 photogrammetry dataset adopting the same assessment methodology and parameter values as used during the previous WBM Oceanics Australia (2003) study.

Analysis of the 2010 photogrammetry has shown significant accretion since 1999. Figure 2-1 shows the profile change between 1999 and 2010 for an example location within Block 2, approximately aligned with Lennox St.

A volumetric analysis of the 1999 and 2010 photogrammetry datasets, shown in Figure 2-2, has found that on average the southern sections of Seven Mile Beach have accreted by the following amounts:

- A45 Block 1 ≈ 40m^3/m
- A45 Block 2 ≈ 100m^3/m
- A45 Block 3 ≈ 50m^3/m

Due to the accreted state of the beach, the regionally adopted design storm bite volume of 200m^3/m has been used for this revised assessment at Lennox Head.

The changes in profile volume directly impact the calculated immediate hazard line for the southern section of Seven Mile Beach. The accreted state of the beach in the updated assessment based on the 2010 photogrammetry results in the immediate hazard line being located further seaward than that previously calculated using the 1999 photogrammetry. The updated immediate hazard lines are shown in Figure 3-1 and Figure 3-2.

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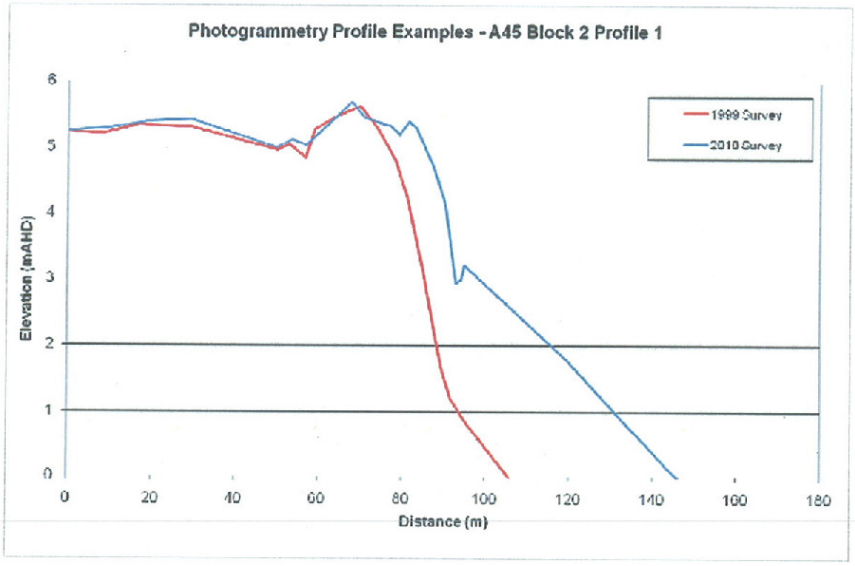

Figure 2-1 Beach Accretion Example

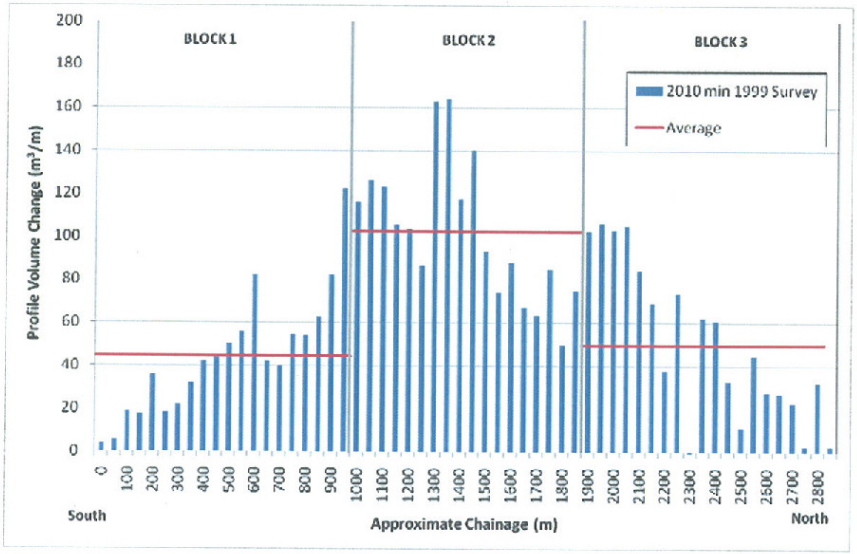

Figure 2-2 Beach Volume Change (1999 to 2010)

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2.3 Long Term Recession Estimates

As part of the Coastline Hazard Definition Study (WBM Oceanics Australia, 2003), calculation of the long term recession estimates were completed accounting for:

- General long-term shoreline recession estimates, based on assessment of historic data and processes; and
- Allowances for shoreline recession resulting from future sea level rise.

As part of this Stage 1 preliminary update of hazard areas, no revisions to the previously adopted general long-term shoreline recession estimates (WBM Oceanics Australia, 2003) have been made.

Allowances for shoreline recession resulting from future sea level rise have been revised using the Bruun Rule, consistent with the methodology adopted during the previous WBM Oceanics Australia (2003) study.

During the 2003 WBM study, allowances for shoreline recession resulting from climate change (Greenhouse Effect) were based on IPCC (1996) sea level rise projections. At that time, the projected rises in sea level over 50 and 100 years were adopted as 0.2 and 0.5m respectively.

In 2009 the Department of Environment, Climate Change and Water (DECCW) published a State Planning Policy defining NSW sea level rise values for 2050 and 2100. The DECCW (2009) policy adopts sea level rise values of 0.4m and 0.9m, relative to the 1990 mean sea level. Accounting for an interim rate of sea level rise of 3mm/yr since 1990 as recommended, sea level rise values of 0.34m (2050) and 0.84m (2100) have been adopted for the current assessment. Based on these sea level rise values, revised Greenhouse shoreline recession estimates of 20m and 45m have been calculated for the 2050 and 2100 planning periods.

A summary of these climate change sea level rise allowances and the updated Greenhouse shoreline recession estimates are summarised in Table 2-1 for the 2050 and 2100 planning periods.

Table 2-1 Sea Level Rise Value Summary

Planning Period	Sea Level Rise Allowances (m)			Updated Greenhouse Shoreline Recession Estimate
	Coastline Hazard Definition Study (WBM Oceanics Australia, 2003)	DECCW (Relative to 1990)	Adopted (Relative to 2011) [a]	
2050	0.2	0.4	0.34	20m
2100	0.5	0.9	0.84	45m

[a] Calculated from DECCW projection accounting for 3mm/yr since 1990

The updated Greenhouse shoreline recession estimates for 50 and 100 year planning periods are 10m and 20m respectively greater than those in the previous hazard assessment (WBM Oceanics Australia, 2003). These updated recession distances for the sea level rise component (refer Table 2-1) apply to all beaches within the Shire subject to any limitations as documented in the previous report. Combining these with the previously assessed general long term shoreline recession estimates, the overall revised long term recession distances for Lennox Head are summarised in Table 2-2 and also shown in Figure 3-1 and Figure 3-2.

Table 2-2 Lennox Head Long Term Recession Distances (m)

Scenario	50 Year Planning Period			100 Year Planning Period		
	Long Term	Greenhouse	Total	Long Term	Greenhouse	Total
Minimum	15	20	35	30	45	75
Best Estimate	25	20	45	50	45	95
Maximum	35	20	55	70	45	115

While the long term recession distances are greater, the accretion since 1999 and the associated location of the immediate hazard zone being further seaward results in:

- the 50 year (2050) hazard zone at Lennox Head also being slightly further seaward (but to a lesser extent) than in the previous assessment; and
- the 100 year (2100) hazard zone being in a similar location or only slightly further landward at the northern end of Lennox Head than in the previous assessment.

Consistent with and as documented in the previous report (WBM Oceanics Australia, 2003), the hazard lines north of Byron Street have been drawn on the basis of no outcropping bedrock or seawalls which may limit erosion potential in this area.

3 Recommendations

Revision of the previously adopted general long term shoreline recession estimates has not been undertaken as part of this Stage 1 preliminary coastal hazard areas update. Analysis of the 2010 photogrammetry has shown significant accretion of the southern section of Seven Mile Beach since 1999. Based on these results, it is recommended that a reassessment of the regional processes and general long term shoreline recession trends be undertaken using this and intermediate dates of photography to update the long term data base of shoreline movements. In addition, further land-based and hydrographic survey data would assist understanding present day conditions and long term changes for such an assessment.

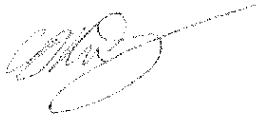
Regionally it is recognised that the Ballina Shire coastline is complex with the prevailing coastal processes being influenced by naturally occurring rocky headlands and shallow nearshore reefs as well as man-made structures such as the Richmond River training walls and seawalls at Lennox Head. It is recognised that there are limitations in using conventional techniques such as the "Bruun Rule" to assess shoreline response to sea level rise in such situations.

To obtain a more detailed revision of the coastal hazards for planning purposes and future updates of the Coastal Zone Management Plan it is recommended that future coastal hazards assessments be undertaken using a shoreline evolution modelling tool capable of accommodating for such coastal features (such as Patterson 2009 and Huxley 2009).

We hope that the above information addresses all the requirements of the Stage 1 preliminary coastal areas update project.

Should you require any additional information or wish to discuss the contents of this letter, please do not hesitate to contact either Craig Witt or myself on 07 3831 6744.

Yours Faithfully
BMT WBM Pty Ltd



Chris Huxley
Senior Coastal Engineer

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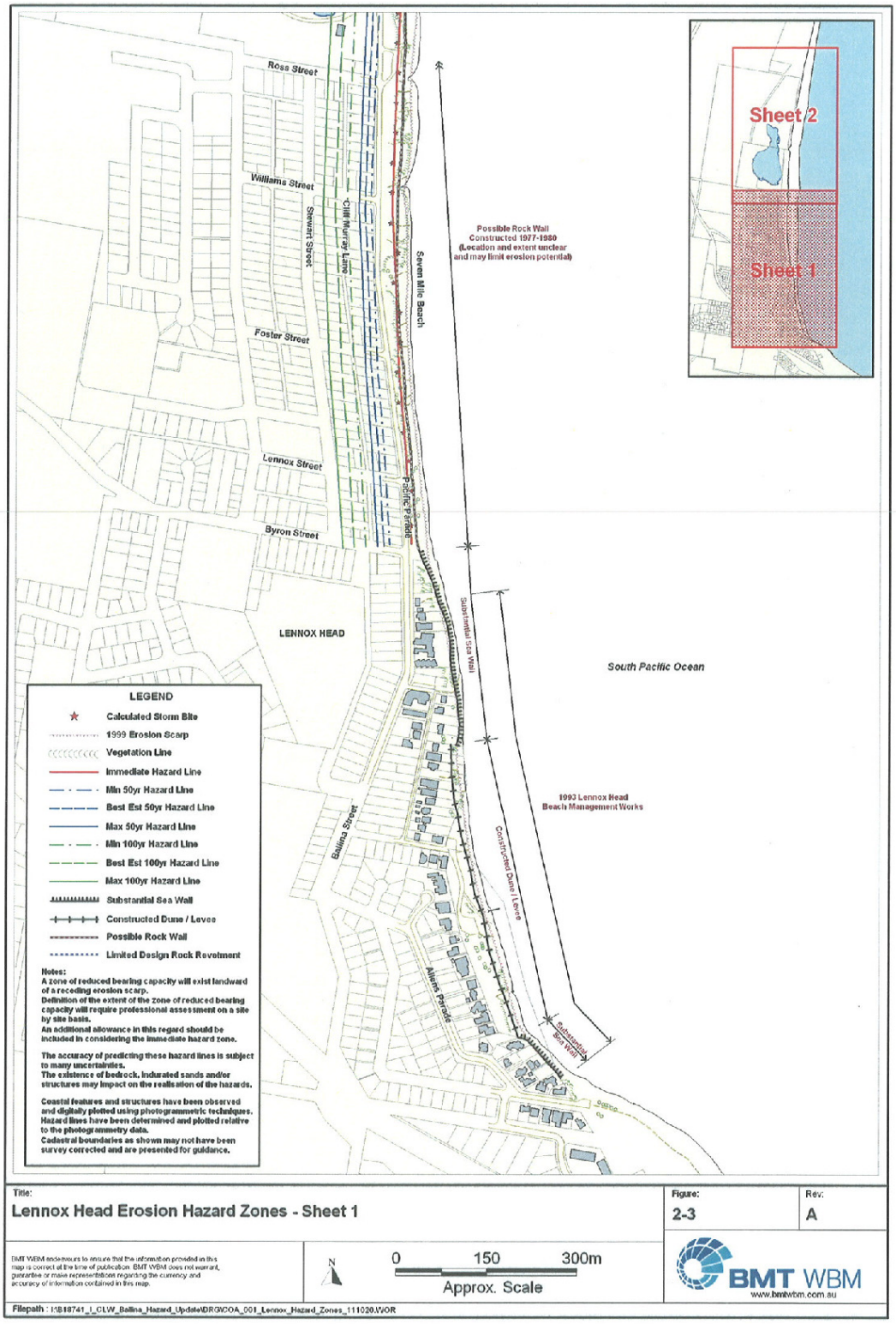
Ross Street
Williams Street
Stewart Street
Cliff Murray Lane
Foster Street
Lennox Street
Byron Street
Pacific Parade
Seven Mile Beach
Possible Rock Wall
Constructed 1977-1980
(Location and extent unclear
and may limit erosion potential)
Sheet 2
Sheet 1
LENNOX HEAD
South Pacific Ocean
Substantial Sea Wall
1993 Lennox Head
Beach Management Works
Constructed Dune / Levee
Ballina Street
Alvens Parade
Substantial Sea Wall
Stairs
LEGEND
Calculated Storm Bite
1999 Erosion Scarp
Vegetation Line
Immediate Hazard Line
Min 50yr Hazard Line
Best Est 50yr Hazard Line
Max 50yr Hazard Line
Min 100yr Hazard Line
Best Est 100yr Hazard Line
Max 100yr Hazard Line
Substantial Sea Wall
Constructed Dune / Levee
Possible Rock Wall
Limited Design Rock Revetment
Notes:
A zone of reduced bearing capacity will exist landward of a receding erosion scarp.
Definition of the extent of the zone of reduced bearing capacity will require professional assessment on a site by site basis.
An additional allowance in this regard should be included in considering the immediate hazard zone.
The accuracy of predicting these hazard lines is subject to many uncertainties.
The existence of bedrock, indurated sands and/or structures may impact on the realisation of the hazards.
Coastal features and structures have been observed and digitally plotted using photogrammetric techniques. Hazard lines have been determined and plotted relative to the photogrammetry data.
Cadastral boundaries as shown may not have been survey corrected and are presented for guidance.
Title:
Lennox Head Erosion Hazard Zones - Sheet 1
Figure:
2-3
Rev:
A
BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
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BMT WBM
www.bmtwbm.com.au
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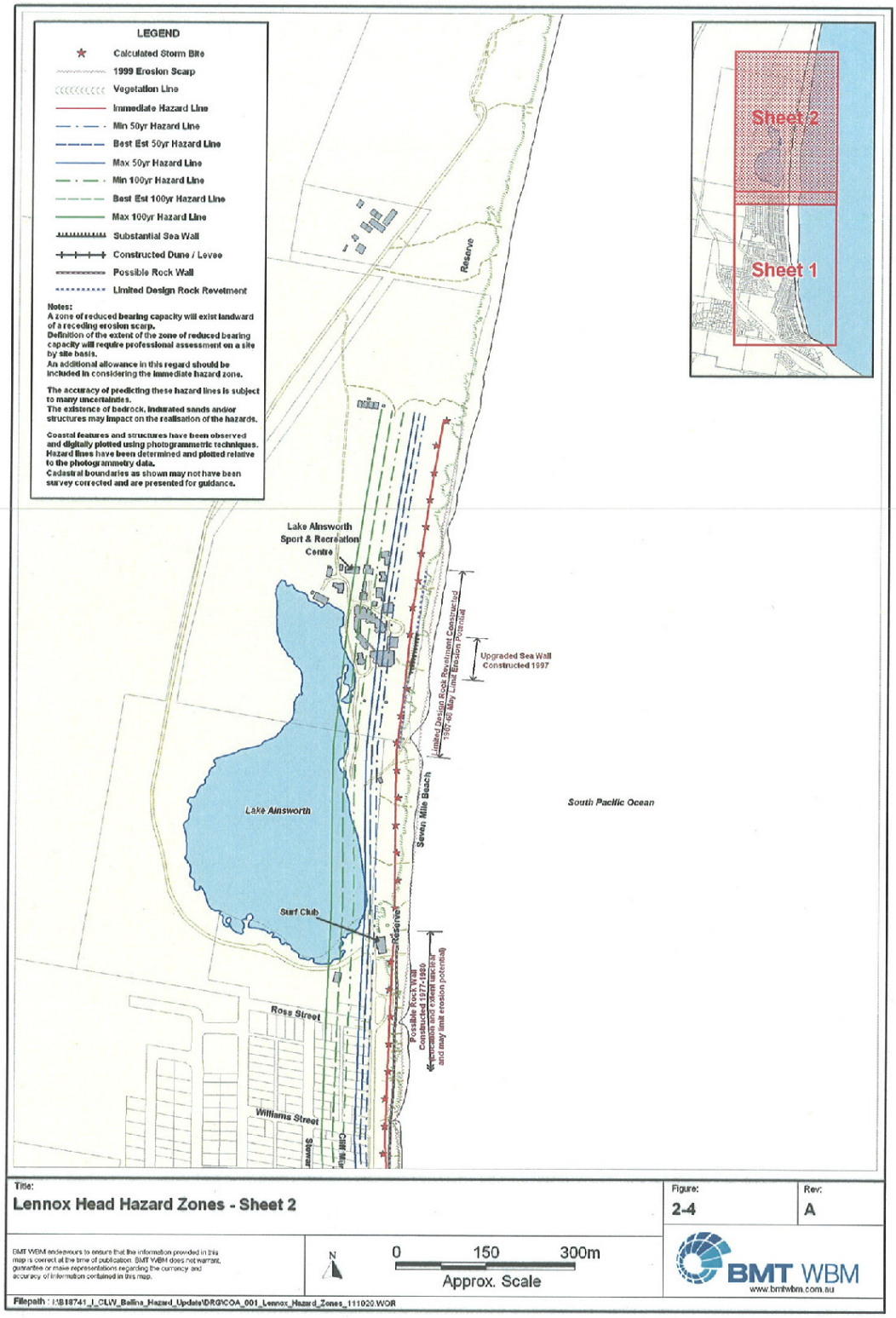
LEGEND
Calculated Storm Bite
1999 Erosion Scarp
Vegetation Line
Immediate Hazard Line
Min 50yr Hazard Line
Best Est 50yr Hazard Line
Max 50yr Hazard Line
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Notes:
A zone of reduced bearing capacity will exist landward of a receding erosion scarp.
Definition of the extent of the zone of reduced bearing capacity will require professional assessment on a site by site basis.
An additional allowance in this regard should be included in considering the immediate hazard zone.
The accuracy of predicting these hazard lines is subject to many uncertainties.
The existence of bedrock, indurated sands and/or structures may impact on the realisation of the hazards.
Coastal features and structures have been observed and digitally plotted using photogrammetric techniques. Hazard lines have been determined and plotted relative to the photogrammetry data.
Cadastral boundaries as shown may not have been survey corrected and are presented for guidance.
Sheet 2
Sheet 1
Reserve
Lake Ainsworth Sport & Recreation Centre
Upgraded Sea Wall Constructed 1997
Limited Design Rock Revetment Constructed 1997 and May Limit Erosion Potential
Lake Ainsworth
Seven Mile Beach
South Pacific Ocean
Surf Club
Reserve
Possible Rock Wall Constructed 1977-1989 remains and extent unclear and may limit erosion potential
Ross Street
Williams Street
Sewer
Title:
Lennox Head Hazard Zones - Sheet 2
Figure:
2-4
Rev:
A
BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.
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Executive Summary

Section 1: Introduction

The coastline of the Ballina Shire is a dynamic environment subject to the natural processes of coastal erosion and accretion.

This report, the Coastal Zone Management Plan for the Ballina Shire coastline (CZMP), represents the culmination of various studies and consultative processes, including:

- *Ballina Coastline Hazard Definition Study* (WBM, 2003) and the *Updated Coastal Hazard Areas for Ballina Shire: Stage 1 – Preliminary Update* (BMT WBM, 2011) concentrating on Lennox Head;
- *Ballina Coastline Management Study – Stage 1 Values Assessment* (GeoLINK, 2007);
- *Ballina Coastline Management Study – Stage 2 Management Options Assessment* (GeoLINK, 2008); and

This CZMP focuses on maintaining or improving the ecological, cultural, recreational, and economic values that are exposed to the following coastal hazards:

- Beach erosion, due to offshore movement of sand from the sub-aerial beach during storms or an extreme or irregular event;
- Shoreline recession due to sediment budget deficits (i.e. more sand leaving a beach than entering it) and sea level rise; and
- Coastal inundation, resulting from extreme ocean storm events, overtopping dunes and inundating land behind the dunes.

Management of coastal ecosystems and community uses of the coastal zone has been thoroughly considered in various other plans. In cases where ecological, cultural, recreational, and economic values are *not* exposed to coastal hazards this CZMP complements or refers to, without duplication, these plans, in particular the Ballina Coastal Reserves Plan of Management (CRPOM) and the Precinct Plans that underpin it.

Section 2: Key findings of the Coastline Hazard Definition Study and the Coastline Management Study

WBM (2003) and BMT WBM (2011) and estimated the potential threat from coastal hazards including:

- Beach erosion
- Shoreline recession; and
- Coastal inundation.

For planning purposes, coastal hazards were estimated for the immediate term (comprising beach erosion only), and for 50 year and 2100 planning period (comprising combinations of beach erosion and shoreline recession). Coastal inundation was not found to be a significant hazard.

There are inherent uncertainties in the estimation of future coastal erosion over timeframes spanning close to 100 years. These uncertainties are accommodated by a conservative approach to developing the recommended management actions and the recommendation for further and on-going monitoring of coastal processes.

Beach erosion estimates for landward movement of the shoreline range between 20 m and 45 m.

Sediment budget deficit erosion estimates for landward movement of the shoreline by 2050 range between 2.5 m and 25 m, and by 2100 the estimates range between 5 m and 50 m.

The sea level rise erosion estimate for landward movement of the shoreline by 2050 is 20 m, and by 2100 45 m.

Sea level rise erosion estimates are derived from a simple application of the Bruun Rule and adoption of the sea level rise estimates presented in *NSW Sea Level Rise Policy Statement* (DECCW, 2010). These sea level rise estimates are for 0.4 m by 2050 and 0.9 m by 2100.

These erosion mechanisms typically occur together with total recession distance an additive combination of these estimates.

The erosion estimates assume no management intervention and, at Lennox Head north of Byron Street no mitigating influence of the existing buried seawall or other existing structures.

Values and threats

GeoLINK (2008) identified many ecological, cultural, social, recreational and economic values ascribed to the Ballina coastline by the community, and where these values might be threatened by coastal erosion hazard.

Ecological values considered to be under threat from coastal erosion include the following.

- Around 76 ha of coastal heath may be lost by 2050 (around 160 ha by 2100).
- Lake Ainsworth may be subject to oceanic breakthrough within 50 years.
- Sandy beaches may be lost 'against' hard structures such as seawalls and natural cobble fields, particularly in Lennox Head and at Boulder Beach.
- Intertidal rock platforms may be subject to significantly altered inundation regimes. This will result in major ecological shifts where there is limited 'space' for intertidal species to move to more suitable ecological niches.

Some local recreation values may be lost such as those ascribed to the beach at Lennox Head due to the beach being lost 'against' the existing seawall and constructed levee if nourishment does not occur.

It is not possible to quantify the potential reduction in economic value of the Ballina coast as a result of coastal erosion due to the diversity and complexity of components that make up this value. The estimated current annual economic value of the Ballina coast is $18M, and the estimated current annual recreation value of the beach (not coast), is $5.1M. These values are likely to reduce overall as a result of coastal erosion.

It is estimated that around $83M and $122M (present value) of private and community assets are under coastal hazard threat by 2050 and 2100 respectively.

Section 3: Recommended Management Actions

Management actions are recommended to mitigate against

- Beach erosion; and
- Shoreline recession; and
- Coastal inundation.

Shoreline recession generally occurs over the long term, while beach erosion is generally the result of a severe storm event, or a closely-spaced series of such events, that can occur at any time. Beach erosion is often followed by a period of accretion.

Cost-effective management of coastal erosion requires a set of complementary short-term (emergency) and long-term management actions to coordinate preparedness, mitigation and recovery in order to maintain coastline amenity.

Coastal Erosion Emergency Events

Coastal erosion emergency events are most likely to arise when severe storm conditions (cyclones or low pressure systems) generating strong onshore winds and large waves, coincide with high spring tides. Coastal erosion emergency events may also occur under relatively benign conditions where, due to the significant lowering of a beach profile as resulting from natural processes, waves are able to scour the back beach erosion escarpment resulting in landward recession of the escarpment. Coastal erosion and or inundation may exacerbate risk to development, infrastructure, and/or persons.

To manage these risks Council has prepared an Emergency Action Subplan for Coastal Erosion (EAS) that is separate but related to this CZMP. The EAS details actions to be carried out by Ballina Shire Council (Council), in response to a coastal erosion emergency event.

North and Central Seven Mile Beach

The broad management objective adopted for this beach unit is to allow coastal processes to proceed under monitoring. Coastal erosion is expected to take the form of a gradual landward movement of the beach and dune system without a substantial change to the nature or extent of these environments, but resulting in a net loss of the coastal heath. No development is under coastal hazard threat in this beach unit.

Lennox Head – North of Byron Street

The broad management objective adopted for this beach unit is to protect development landward of the beach rather than remove development and allow erosion to proceed, i.e. protect rather than retreat. Ideally, the method of protection should provide for a natural beach and dune system that will both act as a buffer to accommodate erosion within the area seaward of development during storm events and be available for recreational and environmental purposes.

In response to Council's decision to protect rather than relocate assets, GeoLINK (2008) identified that the most effective strategy for this beach unit is the *Beach Nourishment with Seawall* option.

BMT WBM (2011) estimates that, in the absence of any management intervention and any mitigating effect from the buried seawall or exiting structures:

- beach erosion may affect Pacific Parade between Byron Street and Lennox Street in the immediate term but only as a result of the effects a zone reduced bearing capacity; and
- coastal hazards are estimated to affect assets as far landward as Cliff Murray Lane by 2050 (including a breach of Lake Ainsworth), and as far landward as Stewart Street by 2100.

Full implementation of all works required to protect against potential future long term recession is not required immediately. Thus the management plan for this beach unit comprises two main steps, investigations and monitoring followed by staged implementation of on-ground works.

Step 1 relates to investigations and monitoring and includes:

- **(Section 3.4.3.1)** Investigate feasibility for a long term sand supply for beach nourishment as a contingency measure to cater for the probability that the historical shoreline recession will continue into the future, exacerbated by sea level rise.
- **(Section 3.4.3.2)** Establish a comprehensive program of beach and dune monitoring integrating various monitoring methods to identify site specific beach processes, short and long-term trends, and trigger points for initiating detailed monitoring and protective works.
- **(Section 3.4.3.3)** Conduct coastal engineering assessment of the structural capacity of the existing buried seawall between Byron Street and the Lennox Head Alstonville Surf Lifesaving Club (SLSC) and the Lake Ainsworth Sports and Recreation Centre (LASRC). This investigation will identify requirements for upgrading their construction to a standard that will provide protection coastal hazards as a 'last line of defence'.

Step 2 relates to on-ground works of beach nourishment and seawall upgrade/ construction as informed by Step 1.

A preliminary concept design of the beach nourishment works has been determined on the basis that the long-term trend of shoreline recession will continue, and its rate is likely to increase in future due to sea level rise. However, the possibility that the shoreline recession rate may stabilise and/or recover naturally is provided for by a strategy that includes ongoing monitoring and 'trigger points' to indicate the need for major remedial works.

Management Plan – Investigations and Monitoring

Confirmation of suitable sources of offshore sand, and the associated design and approval of a program for extraction and placement of that sand, is likely to be a complex and lengthy exercise. Sand nourishment is the primary means by which assets will be protected under this CZMP.

Therefore **Management Action 2013/1** recommends that these investigations are started immediately, followed by design and planning (**Management Action2015/1**), and approvals (**Management Action ST1**) to ensure that works can commence when the trigger point is reached (see **Section 3.4.4.1**). Having the investigation, design, planning and approvals in place is also necessary for any seawall works to commence under this CZMP (see **Section 3.4.4**).

A clear picture of the changing nature of the beach is critical for timely and cost-effective management, primarily by means of identification of the trigger point for implementation of protective works. There are various monitoring methods available for Council to determine both short and long-term trends of shoreline recession rates; current condition of the beach and dune; and whether trigger points have been reached to initiate detailed monitoring or protective works. These include:

- Photogrammetric analysis (minimum basis of monitoring program);
- Land-based surveys;
- Low cost beach monitoring;
- Bathymetric surveys; and
- Coastal conditions monitoring system.

The existing seawall buried under the dune east of Pacific Parade was built between 1977 and 1980. As its structural design, construction and present condition are unknown **Management Action 2014/2** requires that it be assessed with respect to current best practice design standards by a suitably qualified and experienced coastal engineer.

Management Plan – Protective Works

In principle, the trigger for implementation of beach nourishment is reached when the volume of sand available in the beach profile seaward of the 'line of protection' is less than 200 m³/m. Identification of when this trigger point is reached requires:

- determination of the 'line of protection', landward of which property or infrastructure is to be protected and along which a seawall would ultimately be constructed;
- quantification of the sand that is available seaward of that line and above the limiting design storm profile; and
- assessment of the trends in the volume of sand available above the limiting design storm profile.

The beach profile at the time of nourishment and, particularly, the results of the monitoring and identification of trigger points for action will guide nourishment volumes and locations. However, for planning purposes and on the basis of presently available information and assuming a fully depleted beach, it is considered that an initial quantity of about 600,000 m³ will be necessary. The required nourishment volume per lineal metre of beach is expected to vary from 500 m³/m seaward of Byron Street to 250 m³/m seaward of the Lake Ainsworth Sport and Recreation Centre (LASRC).

Under this CZMP, works on upgrading or reconstructing the existing buried seawall, or installation of a new seawall, *cannot* commence without a beach nourishment program in place for this beach unit.

The beach nourishment program described in **Sections 3.4.4.1** and **3.4.4.2**, subject to detailed design, would be adequate to prevent damage to assets from coastal hazards. However, a seawall as a secondary landward 'last line of defence' along this beach unit is also recommended because:

- The coast may be subject to particularly severe erosion conditions, or a series of beach erosion events, that result in a volumetric loss exceeding the current estimate of 200 m³/m described in **Section 3.4.4.1**;
- The timely provision of sand for beach nourishment cannot be guaranteed; and
- The assets under potential coastal hazard threat, including Lake Ainsworth, are of significant value.

Section 3.4.3.3 provides a basic outline of the concept design requirements of the seawall. The alignment of the seawall will follow the 'line of protection' landward of which property or infrastructure is to be protected. It is recommended that the seawall is aligned as far landward as possible to maximise the potential to retain a sandy beach seaward of the wall.

Once a beach nourishment program is in place, it is recommended that seawall works commence following a beach erosion event that exposes the existing seawall, based on the following reasons:

- Significant excavation of the *existing* dune profile would be required to implement seawall works, whether these works comprise repair, reconstruction and/or relocation of the existing buried seawall, installation of a new seawall, or some combination. The process of beach erosion will do much of the excavation that is necessary for the seawall works.
- North of Foster Street the immediate hazard line is approximately 20 m seaward of the Pacific Parade roadway indicating it is currently extremely unlikely that major assets will be damaged by beach erosion, even if more than 200 m³/m of sand is lost in the beach erosion event. Thus, under the estimates put forward in BMT WBM (2011), there is currently very little risk in waiting for the beach erosion event to occur.
- The natural capacity of the dune will be severely reduced during the works period as a result of the excavation, whether it is done by beach erosion or mechanically. While a storm resulting in significant beach erosion can occur at any time, the historical record shows that such events tend to be isolated. Hence it is less likely that a beach erosion event will occur shortly after one has just occurred.

Lennox Head, south of Byron Street

The broad management objective adopted for this beach unit is to protect development landward of the beach rather than remove development and allow erosion to proceed, i.e. protect rather than retreat.

In response to Council's decision to protect rather than relocate assets, GeoLINK (2008) identified

that the most effective strategy for this beach unit is the *Beach Nourishment with Seawall* option.

The existing seawall and levee, if appropriately monitored and maintained, are considered adequate to withstand a large coastal erosion event (or series of smaller events). Thus, theoretically there is no coastal hazard threat to assets in this beach unit. However, the levee appears to have slumped in places from a design height of 5.5 mAHD to around 4.8 mAHD, mainly near access points.

A number of management actions are recommended for this beach unit, some of which are effectively extensions of those recommended for Lennox Head – North of Byron Street. The management actions include:

- Various monitoring and dune management actions;
- Conduct coastal engineering investigation to determine condition and adequacy of constructed levee;
- Upgrade constructed levee on basis of investigation under, including importation and stabilisation of additional sand to ensure that the crest elevation of the constructed levee is returned to the design level of RL 5.5 mAHD;
- Investigate, re-design and install new stormwater drains discharging at the constructed levee;
- Carry out beach nourishment in conjunction with nourishment of the beach further north (if carried out) within ecological constraints associated with the adjacent reef areas to improve beach amenity and access;
- Monitor and maintain the structural integrity of the existing seawalls into the future; and
- Design and install a boardwalk on the existing seawall between Rayners Lane and Byron Street if public foreshore access is constrained too frequently.

Ballina Pocket Beaches and South Ballina Beaches

The broad management objective adopted for these beach units is to allow coastal processes to proceed under monitoring.

Coastal erosion is generally expected to take the form of a gradual landward movement of the beach and dune system without a substantial change to the nature or extent of these environments, but resulting in a net loss of natural areas. The landward extent of erosion is likely to limited at Boulder and Shelley beaches due to the cobble fields that underlie the sand in these locations.

Monitoring by means of photogrammetric analysis is recommended in addition to dune management works where necessary, especially in critical locations such as the Flat Rock tombolo.

MODELLING THE SHORELINE IMPACTS OF RICHMOND RIVER TRAINING WALLS

D Patterson[1]

[1]BMT WBM / University Of Qld, Brisbane, QLD

Introduction

The construction of river entrance training walls is generally aimed at improving navigability of the river mouth where waves and shifting sand shoals otherwise cause shallow and dangerous conditions. Where they are located on coastlines with significant net longshore sand transport, they potentially impact on the adjacent shorelines by interrupting the natural flow of sand along the coast, at least temporarily. The updrift shoreline and, over time, the bar area accrete by trapping the longshore transport. Correspondingly, the downdrift shoreline erodes because the supply there is reduced while the transport away continues, although there may be a localised area of accretion immediately downdrift adjacent to the structure. Where there is gross sand transport back and forth but little or no net transport, the training walls may cause accretion in the immediate vicinity with erosion further away on both sides.

The Richmond River training walls at Ballina (Figure 1) were constructed over a 20 year period from about 1890 to 1910 (WBM Oceanics, 2003; Helman, 2008). The north wall was extended during the 1960s. Huang et al (1999) studied the adjacent shoreline changes between 1947 and 1991 from photogrammetric analysis and concluded that:

- The walls caused accretion at both South Ballina and Lighthouse Beach;
- Storm erosion in 1974 caused extensive erosion of all beaches in the area and temporarily disrupted the prevailing trend of adjacent shoreline changes;
- After an initial high rate of shoreline change, by 1981-1991 an equilibrium shoreline position was being approached; and
- By that time, total sand bypassing of the walls had been restored.

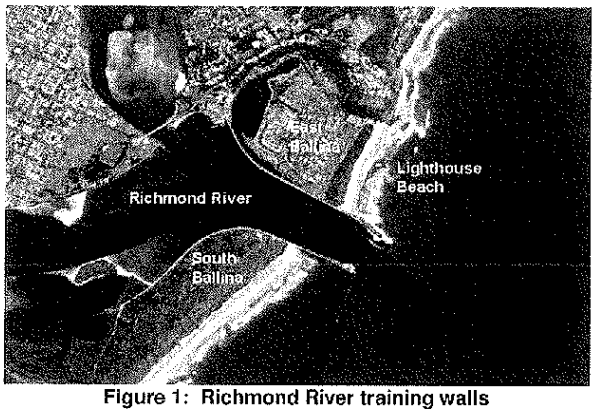

Figure 1: Richmond River training walls

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WBM Oceanics Australia (2003) analysed the photogrammetric data for the period between 1947 and 2000 and also reviewed other available information on changes following wall construction, finding that there was a significant northward net longshore sand transport, possibly as high as 350,000 m^3/year at the time of wall construction, with associated substantial accretion along about 8 to 10 km of the shoreline south of the walls. Patterson (2007b) analysed longshore transport rates along the whole region from Iluka to the Gold Coast and found a consistent progressively increasing pattern of net transport, with a contemporary rate at South Ballina of about 260,000 m^3/year that may have been higher prior to training wall construction.

This pattern of significant northward net longshore transport and extensive shoreline accretion south of the walls suggests that there would have been a corresponding large-scale net loss of sand further north. This may have affected beaches north to Lennox Head (Figure 2). This has been assessed by the modelling undertaken, as outlined below.

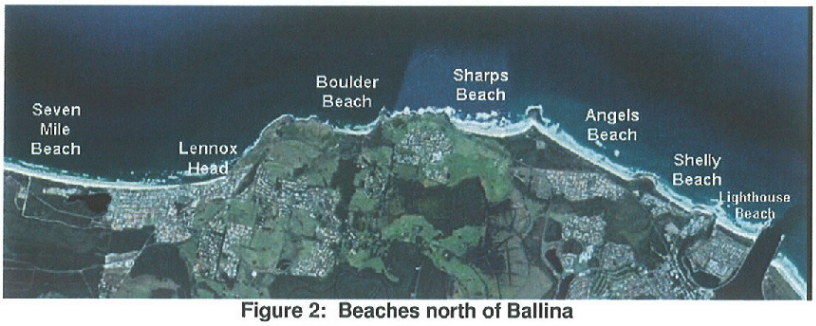

Figure 2: Beaches north of Ballina

Measured Historical Shoreline Changes

Photogrammetric Data

The photogrammetric data represents the only reliable source of quantitative information on shoreline changes in the region. The earliest date of suitable photography is 1947, some 55 years after commencement of the training wall construction. This data shows only the behaviour above the water level, potentially missing a large proportion of the total profile changes. Examples of the photogrammetry are shown in Figure 3 for South Ballina, Lighthouse Beach, Angels Beach and Seven Mile Beach (Lennox Head).

This data shows that:

- There had been considerable erosion of the main 10m high dune system north from Angels Beach to Seven Mile Beach prior to 1947;
- There is a lag in the major dune erosion with distance north, Seven Mile Beach still showing progressive retreat well after the beaches closer to Ballina had reached their most landward position;
- The erosion of the beaches north of Ballina continued through to 1967 – 1974 after which the dune system has accreted at a lower level of about 5m;

- There was apparent erosion with a steep scarp at South Ballina through to 1974, after which that beach and dune system has shown steady accretion; and
- Lighthouse Beach has experienced significant accretion of a substantial dune system since 1947.

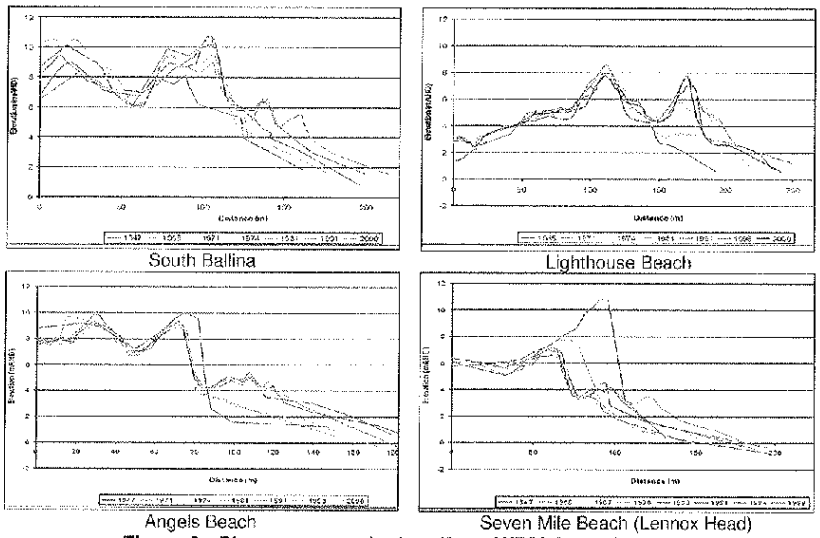

Figure 3: Photogrammetric data (from WBM Oceanics 2003)

Observed Erosion Sequences

Anecdotal evidence is that the most severe erosion events in memory occurred in 1954, 1967 and 1974 (WBM Oceanics 2003). The 1954 cyclone tracked over Tweed Heads at 985 Hpa causing major erosion south from the Gold Coast. A series of cyclones affected the area in 1967 and the dune was temporarily breached through to Lake Ainsworth (Ardill & Assoc., 1988). Cyclones Pam and Zoe struck northern NSW in February and March 1974 with more severe beach erosion. The photogrammetric data clearly incorporates that erosion, as identified by Huang et al (1999).

WRL (1986) notes that the Richmond River training walls have had an effect on the movement of sand along the coast and the erosion at Lennox Head could be linked to this. Ardill & Assoc. (1988) records that the original 1884 subdivision there has a roadway reserve 100m wide from HWM and that newspaper articles observe considerable erosion between 1922 and 1946, with rock protection works commencing in the early 1940s. Recession from the top of bank on a 1922 plan to the top of the scarp in 1947 was about 20m. Helman (2008) records the retreat and breaching of the dune to a freshwater hind-dune lagoon at the southern end of the township sometime soon after 1913.

Existing coastal system processes

Geological evidence suggests a long term trend of shoreline recession at Lennox Head and Seven Mile Beach, with an exposed tree stump dated at 3,765 (±70) years BP exposed on the peat nearshore reef there (Geomarine 1990), indicating a former dune barrier seaward of that. Patterson (2007b) analysed longshore transport rates along the whole region from Iluka to the Gold Coast and found a consistent progressively increasing pattern of net transport, with a contemporary rate at South Ballina of about 260,000 m^3/year increasing to over 400,000 m^3/yr at Tallow Beach (Figure 4). This gradient in longshore transport could be construed as the cause of the erosion at Seven Mile Beach.

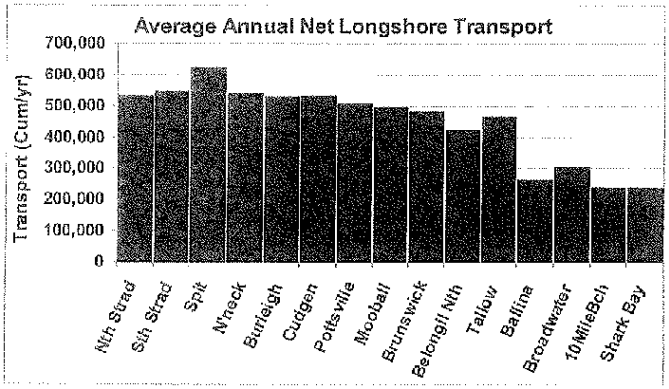

Figure 4 Calculated Annual Net Longshore Transport Rates (Patterson 2007b)

However, it has been hypothesised (Roy, 2001; Cowell et al, 2001; Goodwin et al, 2005) that there may be an onshore supply of sand to the beaches from the inner shelf area where the profile slope is flatter than the commonly observed 'equilibrium' slope of about 1 degree (1:55). This supply compensates for the sand loss due to the longshore transport gradient. The so-called Byron sand lobe that extends south from Cape Byron to around Ballina is a feature that creates such flatter profile slopes (Figure 5). Analysis by the writer of profile changes over the period 1966 to 2002 at The Spit, Gold Coast where the profile has a disequilibrium bulge compared with adjacent areas (eg Broadbeach) (Figure 5) indicates the potential for an onshore supply of sand into the active upper profile of about 5-10 m^3/m/yr at depths of 12 to 15m, reducing to 1 m^3/m/yr at 18m (Patterson 2007a).

The writer has developed an empirical relationship for calculating the annual average onshore supply rate for the wave climate and sand properties along this region as functions of water depth and seabed slope (refer below). Applying this to the profiles at the Byron sand lobe suggest onshore supply rates of about 5 m^3/m/yr at 15m depth, reducing to zero further south at South Ballina. This supports the hypothesis that there is a residual supply of sand to these beaches that needs to be catered for in the modelling.

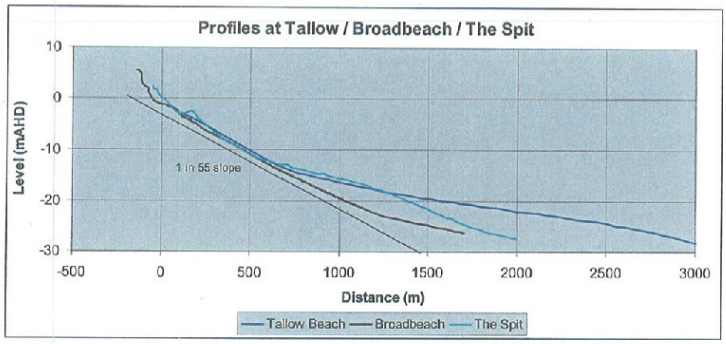

Figure 5 Byron sand lobe profile

Shoreline Modelling

Modelling Software

Shoreline evolution modelling has been undertaken with a new innovative shoreline evolution modelling software package developed by the writer as part of his doctoral research into long term Pleistocene-Holocene coastline changes in the region. The model provides for a range of features and processes not available in other packages, including large-scale sea level change, bedrock features that may be submerged reefs or headlands depending on the sea level at any time, two-dimensional coastline and continental shelf representation, long term cross-shore sand transport in water depths beyond the upper profile zone of frequent storm erosion exchange and versatile representation of breakwaters and rivers.

The model is based on the fundamental one-line theory to describe variations in the cross-shore shoreline position (x) as a function of alongshore distance (y), using equation 1:

$$\frac{\partial x}{\partial t}+\frac{1}{(D_d+D_{cl})}\left[\frac{\partial Q}{\partial y}-q_{on}\right]=0 \qquad (1)$$

where Q is the longshore transport, D_d is the dune height, D_{cl} is the depth of closure and q_{on} is the onshore transport per metre length of shoreline from outside the depth of closure, within the model framework as illustrated in Figure 6.

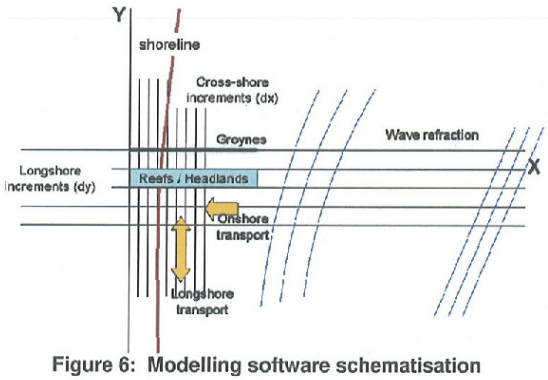

Figure 6: Modelling software schematisation

The model is run in time-stepping increments driven by time series of deep water waves and sea level. The waves are refracted using linear theory in four steps to the breakpoint with progressively varying depth contour alignments, thereby overcoming the constraint of straight and parallel depth contours and small shoreline angles to the alongshore Y axis. The longshore transport Q is calculated using the conventional CERC formula. For this modelling, q_{om} is based on annual average rates derived from analysis of profile changes at The Spit, Gold Coast (Patterson 2007a) as:

$$q_{om} = q_p\left(1-\frac{S}{S_{eq}}\right)^n \qquad (2)$$

where q_p is the potential transport for a flat seabed derived for this modelling for $n = 0.4$ adopted as giving the best fit with the data, S is the bed slope and S_{eq} is the equilibrium bed slope derived from measured Gold Coast profiles as f^n(depth).

The model

The modelled coastline is complex with extended sections of headlands and small beaches perched on sloping bedrock. Lennox Head has a shallow reef structure extending over 200m out from the shoreline (Figure 7). A key feature of the model software is its highly flexible representation of bedrock features and structures such that this coastline may be simulated reasonably well. For example, headlands and reefs are represented as structures that occupy whole elements whereas groynes are located at the boundary between elements. Reefs may be set at any level and with any seaward extent and slope (Figure 7).

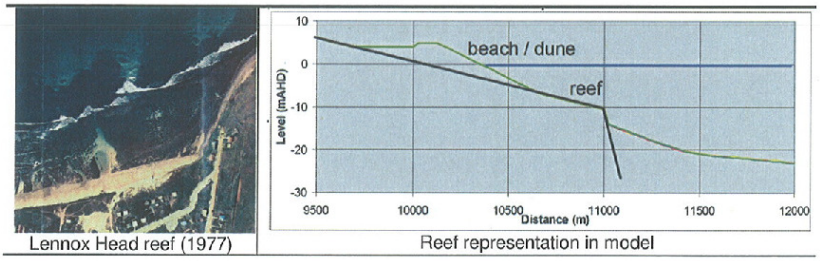

Figure 7 Sloping reef representation

Further, the coastline south of the river faces southeast and the longshore transport regime is critically dependent on the southerly swell for the northward net transport there (Patterson 2007b). The use of suitable deep water wave data and the multi-step wave refraction process deals with this. The alignment of the 15m depth contour is progressively updated as the shoreline position and alignment change, giving realistic calculation of the nearshore refraction and breaking wave angles to the shoreline.

The model extent is illustrated in Figure 8. It has 240 alongshore elements of 250m length (60,000m) and 2,000 cross-shore elements of 25m length (50,000m) extending seawards from behind the dune to beyond the edge of the continental shelf. The coastline was represented directly as the prototype plan shape and the continental shelf slope approximated at each longshore element from chart depth data.

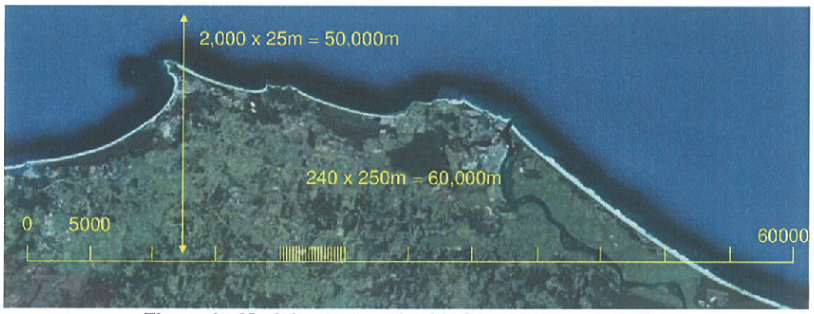

Figure 8: Model extent and grid element representation

Model simulations

The model uses a repeated 5 year cycle of recorded waves off Cape Byron. The model was calibrated to give an average annual net longshore transport of about 320,000 m^3/year at the Richmond River without the training walls. An onshore supply to the beaches was applied, increasing from zero near Ballina to 5 m^3/m/yr at Suffolk Park / Tallow Beach, as discussed above.

7

Following an initial 'warm-up' period of 100 years to establish an essentially stable balance of shoreline processes, the model was run over three 200 year simulation periods commencing at 1895, all with identical longshore and onshore transport relationship settings, representing:

- **Scenario 1:** The base case without training walls or sea level rise;
- **Scenario 2:** The historical case with training walls to date and projected to year 2095 without sea level rise; and
- **Scenario 3:** Scenario 2 with 0.5m sea level rise from year 1995 to 2095.

It was adopted for modelling purposes that the training walls were established over the period 1895 to 1910. Predictive modelling to year 2095 without and with sea level rise has been undertaken to assess the likely trend of shoreline change to date and over the next 100 years as well as the relative impact of 0.5m sea level rise over the next 100 years. The seawalls at Lennox Head are not represented. Modelled shoreline changes there are thus equivalent to those occurring without the control of those structures.

While the model may not have been perfectly in balance in terms of longshore / onshore transport and shoreline stability at the start of each scenario run, it is to be noted that the true nature of such balance is not actually known and, by using the model as a tool to facilitate analysis relative to the baseline case, the incremental impacts of the training walls and sea level rise should be reasonably well identified.

The model results have been correlated against the measured beach/dune quantity changes from the photogrammetry for the period after 1947 for Angels Beach and Lennox Head (Figures 9 and 11 respectively with locations of Lennox Head survey blocks shown in Figure 10). The model indicates that substantial impacts of the training walls had already passed along the coastline prior to 1947 and some subjective benchmarking of the sand quantity change at that date was needed. Furthermore, in correlating the model and measured quantities, provision must be made for the beach/dune erosion due to the storm erosion, which affected the area during the 1950s to 1970s, particularly 1974 (Huang, 1999), and the subsequent recovery of the dune system associated with short term cross-shore exchanges of sand that are not included in the model simulations.

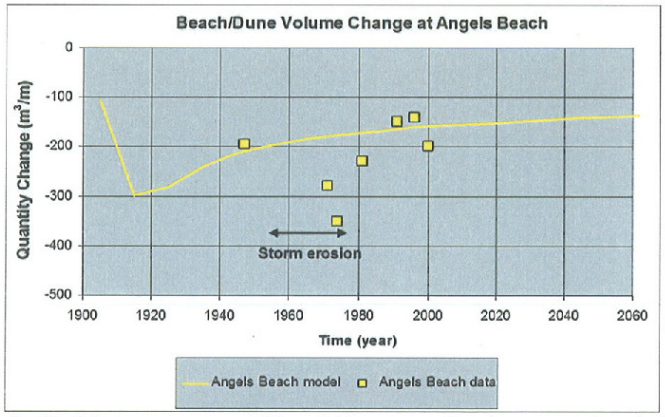

Figure 9: Model versus measured beach/dune quantity changes at Angels Beach

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It is of note in Figure 10 that Blocks 1 and 2 cover the area of nearshore reef whereas Blocks 3 and 4 are north of any apparent reef, allowing more recession. The model results in Figure 11 also show the predicted trend of change at Lennox Head in the absence of future sea level rise, indicating some further recovery of the shoreline at the southern end of Lennox Head and relative future stability along Seven Mile Beach.

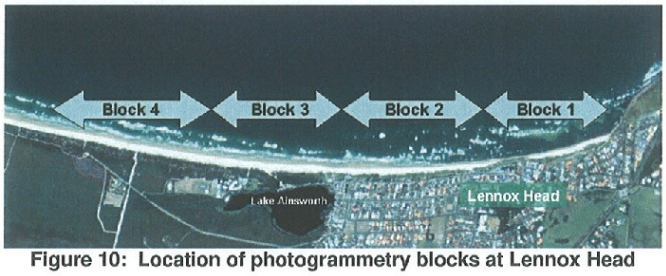

Figure 10: Location of photogrammetry blocks at Lennox Head

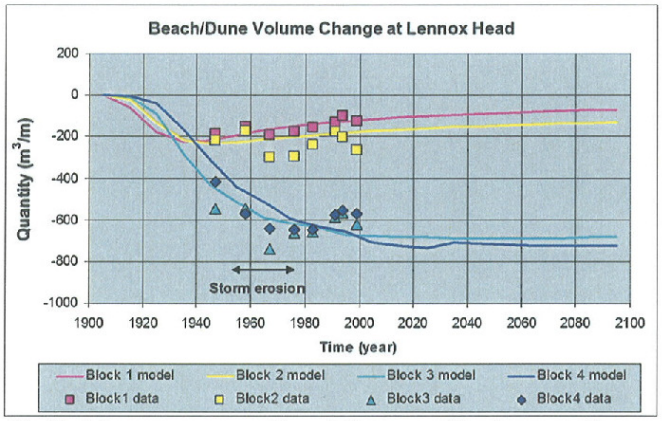

Figure 11: Model versus measured beach/dune quantity changes at Lennox Head

The model indicates that there has been a long term reduction in the annual average rate of transport past the Richmond River and the downdrift beaches (Figure 12). Plan view plots of the sequential shoreline positions at 10 year intervals derived from the model are shown in Figures 13 and 14. These show importantly that the rocky and pocket beach nature of the coastline between Ballina and Lennox Head are such that:

- only limited erosion occurs due to the bedrock controls of the headlands and underlying reefs; and
- a substantial proportion of the sand losses caused by the training walls are transferred north relatively quickly to Lennox Head and Seven Mile Beach.

The model suggests that the downdrift erosion from the training walls has not yet affected the beaches at Suffolk Park or Tallow Beach. However there is potential for the erosion to be felt there over the next 100 years.

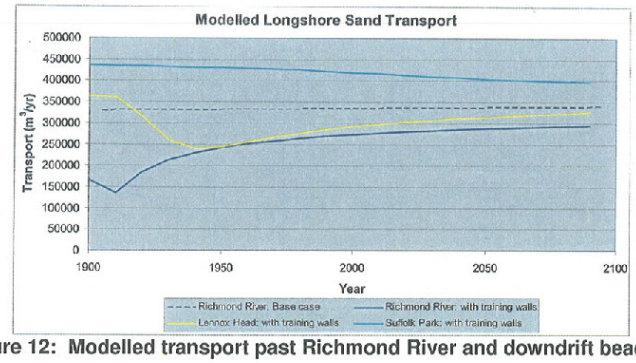

Figure 12: Modelled transport past Richmond River and downdrift beaches

The erosion will be exacerbated by sea level rise, particularly immediately north of each controlling headland. The impacts of sea level rise have been identified in the modelling by subtracting the result for Scenario 2 from that for Scenario 3 in terms of shoreline position changes in the model. This is shown in Figure 14. This indicates the normal 'Bruun Rule' extent of shoreline recession along the extended beaches at the south and north ends of the model but a more complex interaction of cross-shore and longshore effects where the coastline would continue to respond to headland and reef controls.

Discussion and Conclusions

Modelling the coastline at and north from Ballina is highly complex because of the variable shoreline alignment and, particularly, the extensive presence of bedrock headlands and reefs that control the sand transport processes. There is little doubt that the modelling undertaken does not represent those features and processes with a high level of accuracy. However, it is considered that the essential processes and controls are reasonably well simulated such that the impacts of the training walls have been identified realistically.

The key conclusions are:

- The training walls appear to be the dominant influence on the sustained shoreline erosion that has been experienced at Lennox Head and Seven Mile Beach.
- In the absence of sea level rise, the shoreline appears to be recovering slightly at south Lennox Head and has stabilized along Seven Mile Beach. Ongoing monitoring is needed to confirm this.
- Despite the above, there appears to have been a long term reduction in the longshore transport past the training walls and along Seven Mile Beach and some impact of the training walls may start to be felt at Suffolk Park over the next 100 years.
- Sea level rise will exacerbate the erosion at all beaches in a manner that is more complex than that indicated by application of the 'Bruun Rule', with headland controls minimizing recession updrift and exacerbating recession (up to 2-3 times) downdrift of those controls. This is a significant issue for future management considerations. Note that the modeled behaviour at Lennox Head does not include the control on recession provided by the seawalls constructed there.

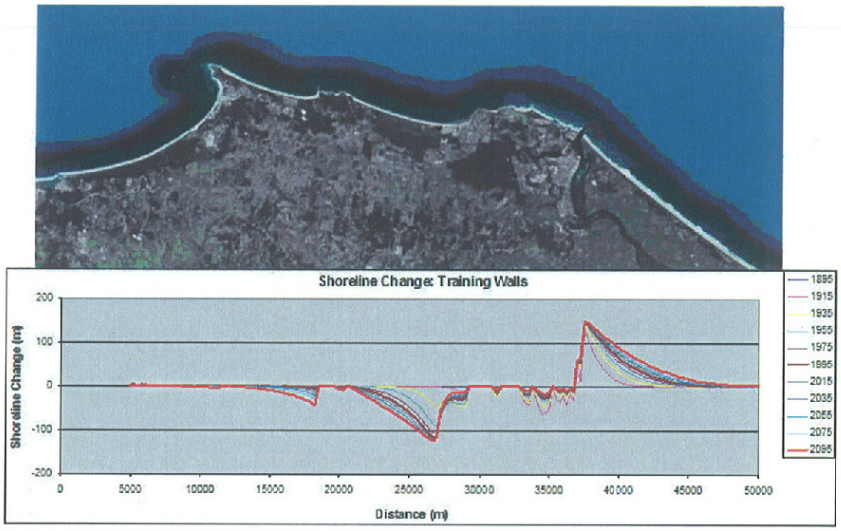

Figure 12: Modelled impacts of training walls on shoreline position

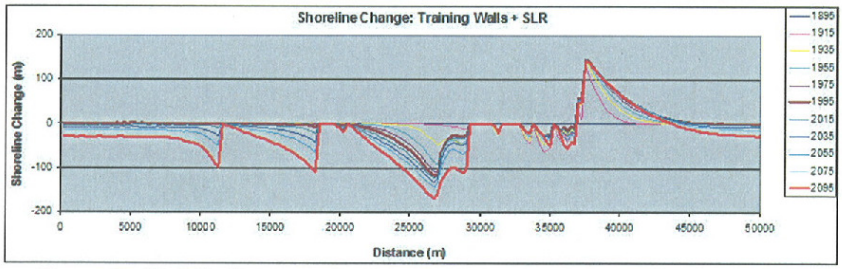

Figure 13: Modelled impacts of training walls and sea level rise on shoreline position

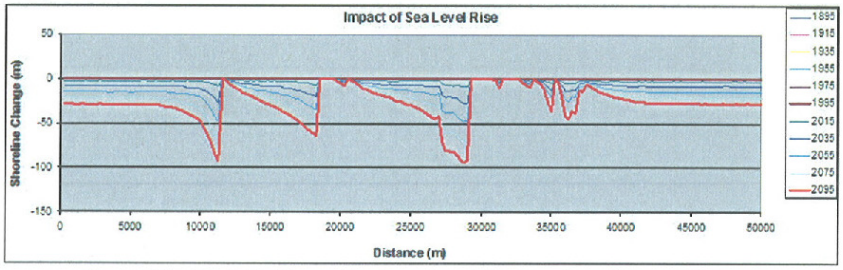

Figure 14: Modelled impacts of sea level rise on shoreline position

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- The modeling software used for this analysis is versatile and effective for this application involving complex headland and reef structures and sea level rise.

Acknowledgements

I wish to thank the NSW Department of Environment and Climate Change for making available the Byron wave data used in the analysis. BMT WBM Pty Ltd and the Coastal Division, Civil Engineering, University of Queensland have supported the research undertaken in developing and applying the modelling software.

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Table 4.2 Recommended Coastal Zone Management Actions – Monitoring

Code	Beach units	Recommended Coastal Zone Management Actions – Monitoring	Responsibility (lead in bold)	Performance measure	Frequency / timeframe	Cost bracket	Funding (Table 4.1)
M1	LHN LHS	Conduct aerial orthophoto pass and photogrammetric analysis. (Note: next aerial orthophoto passes currently expected in 2013, 2016 and 2019.)	**BSC**, OEH	Analysis complete	Approximately every 3 years. First analysis expected in 2013	1	S1, L1, L2, L4, L5, L6, L7, L8, L9
M2	SMB BB BPB	Conduct aerial orthophoto pass and photogrammetric analysis.	**BSC**, OEH	Analysis complete	Approximately every 6 years. First analysis expected in 2016 (including 2013 photo)	2	S1, L1, L2, L4, L5, L6, L7, L8, L9
M3	SBB	Conduct aerial orthophoto pass and photogrammetric analysis.	**BSC**, OEH	Analysis complete	Approximately every 9 years First analysis expected in 2019 (including 2013 and 2016 photos)	2	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9
M4	LHN	Conduct land-based surveys at locations 5, 6 and 7 (refer **Illustration 3.4**)	**BSC**	Surveys complete	Every six months for first 5 years then annually, beginning 2012-13		
M5	All	Review historical data set of land-based and bathymetric surveys and determine value of developing on-going survey program to build on existing data. Based on results of existing data review develop survey program and modify **Management Actions M6** and **M7** accordingly.	**BSC**	Survey monitoring program developed	2012-13	1	S1, L1, L2, L4, L5, L6, L7, L8, L9
M6	LHN LHS	Conduct land-based surveys	**BSC**, OEH	Surveys conducted and recorded	Refer **Section 3.4.3.2**, ideally after major storms, 6 monthly for first 5 years, then annually	1 (per survey)	S1, L1, L2, L4, L5, L6, L7, L8, L9
M7	LHN LHS	Conduct bathymetric surveys	**BSC**, OEH	Surveys conducted and recorded	Refer **Section 3.4.3.2**	TBC	S1, L1, L2, L4, L5, L6, L7, L8, L9
M8	LHN	Conduct low cost beach monitoring at SLSC (refer **Appendix B**)	**BSC**, OEH	Data provided	Weekly to monthly depending on volunteer commitment / funding	1 (per year)	L1, L2, L4, L5, L6, L7, L8, L9
M9	All	Conduct visual inspection and compile photographic record (from set locations) of beaches, seawalls (LHN and LHS), dunes, levees and boardwalk (LHS). Concentrate on critical areas such as Lennox Head, Boulder Beach and Flat Rock tombolo.	**BSC**, OEH	Data collated, documented and reviewed	Annual and after major storms	1 (per inspection and report)	L1, L2, L4, L5, L6, L7, L8, L9
M10	All	Analyse all monitoring data and prepare detailed report including a review of currency of existing hazard zones and the need, if any, to have hazards recalculated.	**BSC**, OEH	Report prepared	After major storms, or every 6 years (first in 2016)	2 (per report)	L1, L2, L4, L5, L6, L7, L8, L9

Table 4.3 Recommended Coastal Zone Management Actions – Dune Management Works

Code	Beach units	Recommended Coastal Zone Management Action – On-going Works	Responsibility (lead in bold)	Performance measure	Cost bracket	Funding (Table 4.1)
DM1	All	Continue program to manage foredunes in line with Precinct Plans including the following broad actions: ▪ Conduct regular inspections (coordinated with Emergency Action Subplan) to confirm condition of dunes. ▪ Install and maintain sand capture fencing to complement the natural capacity of foredune vegetation in holding sand that is blown onto dunes, thereby increasing the sediment store and erosion mitigation capacity of dunes. ▪ Locate sand capture fencing based on regular inspection of condition of foredune and shift seaward if sufficiently 'full' or relocate entirely if toe of fore-dune is considered to be adequately seaward; and ▪ Revegetate foredune where practicable to increase rates of natural sand capture and the consolidating influence of root systems. ▪ Inspections and works should be focused on critical areas such as; o Between Byron and Foster streets; o Adjacent to stormwater outlets at Lennox Head village; o Adjacent to beach access points; and o Around the base of the Flat Rock tombolo.	**BSC**	Program continued	Op	L1, L2, L4, L5, L6, L7, L8, L9
DM2	All	Continue program to manage beach access points in line with all Precinct Plans including the following broad actions: ▪ Close informal beach access paths over dunes by fencing off, conducting revegetation and installing signage noting the revegetation site and directing people to the nearest formal beach access point. ▪ Monitor beach access points to ensure that any lowering of the foredune or damage to foredune vegetation associated with their installation and use does not occur to such an extent so as to exacerbate coastal hazard threat. ▪ Develop and implement a prioritised program of installing board-and-chain walkways and signage to identify and formalise appropriate beach access points throughout all beaches under Council management (i.e. north of the Richmond River) ▪ Following erosion events, remove sections of board-and-chain walkways that overhang scarps and/or conduct localised beach scraping to maintain suitable grades onto the main body of the beach. Reinstall necessary sections of walkways as the beach and foredune naturally accrete following the erosion event.	**BSC**	Program continued	Op	L1, L2, L4, L5, L6, L7, L8, L9

Table 4.4 Recommended Coastal Zone Management Actions – Protective Works and Associated Investigations

Year-priority	Beach units	Recommended Coastal Zone Management Action – Long-Term Works	Responsibility (lead in bold)	Performance measure	Cost bracket	Funding (Table 4.1)
2013-2014 Financial Year						
2013/1	LHN LHS	Investigate the feasibility of marine, estuarine and terrestrial sources of nourishment sand and the associated design of beach nourishment works. Investigation to include statutory planning and policy requirements, planning, comparing costs, and social and environmental impacts at source and destination locations.	**BSC**	Identification of suitable source. Design of beach nourishment works.	3	L1, L2, L4, L5, L6, L7, L8, L9
2013/2	BB	Conduct survey and investigations, prepare designs and obtain approval for protective works to prevent loss of walking track at the southern end of Boulder Beach.	**BSC**	Design complete Approval obtained	1	S1, S2, L1, L2, L4, L5, L6, L8
2013/3	All	Implement Precinct Plans	**BSC**	As per management actions in Precinct Plans	Various	Various
2014-15 Financial Year						
2014/1	LHS	Conduct coastal engineering investigation to determine condition and adequacy of the constructed levee to mitigate against hazards from design storm events and shoreline recession. Investigation to include survey of the levee to inform **Management Action 2015/2**, for returning the levee to a minimum design crest elevation of RL 5.5 mAHD.	**BSC**	Investigation complete and determination made	3	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9, P1
2014/2	LHN	Conduct coastal engineering investigation to determine alignment, condition and adequacy of existing buried seawall between Byron Street and the SLSC and Lake Ainsworth Sport and Recreation Centre. Investigation is to include survey of the dune to inform **Management Action ST2** to ensure the dune has a minimum crest elevation of RL 6.0 mAHD.	**BSC**, OEH, DSTA	Investigation complete and determination made	3	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9, P1
2014/3	BB	Install rock revetment, earth backfill and track works to prevent loss of walking track at southern end of Boulder Beach.	**BSC**	Works in place	3	S1, S2, L1, L2, L4, L5, L6, L8
2014/4	All	Implement Precinct Plans	**BSC**	As per management actions in Precinct Plans	Various	Various
2015-16 Financial Year						
2015/1	LHN LHS	Prepare design and EIS for beach nourishment on the basis of investigations initiated by **Management Action 2013/1**.	**BSC**, OEH	Design and EIS completed	4	S1, L1, L2, L4, L5, L6, L7, L8, L9
2015/2	LHS	Upgrade constructed levee on basis of investigation under Management Action 2014/1. Upgrade to include importation and stabilisation of additional sand to ensure that the crest elevation of the constructed levee is returned to the design level of RL 5.5 mAHD along its full length and maintained at that level.	**BSC**, DECCW	Levee core upgraded as necessary Crest elevation of levee is RL 5.5 mAHD	3	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9, P1

Year-priority	Beach units	Recommended Coastal Zone Management Action – Long Term Works	Responsibility (lead in bold)	Performance measure	Cost bracket	Funding (Table 4.1)
2015/3	LHN LHS	Investigate potential to redesign stormwater outlets to minimise adverse effects on foredune, in particular those discharging near ▪ Ross Street ▪ Williams Street ▪ Lennox Street ▪ Foster Street ▪ Rutherford Street ▪ The southern end of the constructed levee at the southern end of Seven Mile Beach	**BSC**	Investigations complete	2	L1, L2, L4, L5, L6, L7, L8, L9
2015/4	All	Implement Precinct Plans	**BSC**	As per management actions in Precinct Plans	Various	Various
2016-17 Financial Year						
2016/1	LHN LHS	Redesign and install new stormwater drains if investigation determines redesign is feasible. (Note: can be carried over to following years if investigation results in multiple and/or expensive redesigns.)	**BSC**	Works in place	3-4	L1, L2, L4, L5, L6, L8
2016/2	All	Implement Precinct Plans	**BSC**	As per management actions in Precinct Plans	Various	Various
Short-term (5-15 years)						
ST1	LHN LHS	Obtain approvals for beach nourishment program.	**BSC**	Approval obtained	2	S1, L1, L2, L4, L5, L6, L7, L8, L9
ST2	LHN	Following suitable beach erosion event, upgrade or reconstruct existing buried seawall, or install a new seawall between Byron Street and the SLSC and Lake Ainsworth Sport and Recreation Centre on the basis of investigations under Management Action 2014/2. Upgrade to include importation and stabilisation of additional sand to ensure that the crest elevation of the dune above the existing buried seawall is at or above RL 6.0 mAHD.	**BSC**, OEH, DSTA, DSR	Seawall upgraded as necessary Dune crest is RL 6.0 mAHD	5	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9, P1
ST3	LHN LHS	Implement beach nourishment program coordinated with seawall works.	**BSC**, OEH	Beach nourishment conducted	5	Special state and Federal funding
Mid-term (15-25 years)						
MT1	LHN LHS	Conduct detailed investigations to ensure continuing adequacy of protective measures.	**BSC**, OEH	Investigations complete	2	
MT2	LHN LHS	Implement maintenance measures of dunes, seawalls and levee as required on basis of monitoring program	**BSC**, OEH	Implemented as required	2-3	L1, L2, L4, L5, L6, L7, L8, L9

Year-priority	Beach units	Recommended Coastal Zone Management Action – Long-Term Works	Responsibility (lead in bold)	Performance measure	Cost bracket	Funding (Table 4.1)
MT3	LHS	Design and install boardwalk on existing seawall between Rayners Lane and Byron Street if public foreshore access is constrained too frequently.	**BSC**	Boardwalk installed	4	State and Federal funding L1, L2, L4, L5, L6, L7, L8, L9
Long-term (25+ years)						
LT1	LHN LHS	Conduct re-nourishment of beach as necessary (if possible)	**BSC**	Re-nourishment conducted in a timely fashion	Variable	S1, S2, L1, L2, L4, L5, L6, L7, L8, L9 P1

The Hon. Robyn Parker MP
Minister for the Environment
Minister for Heritage

DOC12/40363

Mr Paul Hickey
General Manager
Ballina Shire Council
PO Box 450
BALLINA NSW 2478

Dear Mr Hickey

I am writing to provide a 12 month extension to,the completion deadline for Ballina Shire Council's draft Coastal Zone Management Plan (CZMP), in order to allow time to identify potential future coastal hazards which reflect local conditions. The extension also provides time for Council to transition to the new arrangements for coastal hazard management which the Government is progressively developing.

Council is currently preparing a draft CZMP for Seven Mile Beach, Lennox Head under a Ministerial direction issued under section 55B of the *Coastal Protection Act 1979* during the term of the former Government. The Office of Environment and Heritage (OEH) understands that council is currently intending to complete its plan by December 2012. The due date for the plan has now been extended to December 2013.

Further information on the stage one reforms, which may assist Council prepare its plan, is available on the OEH website at www.environment.nsw.gov.au/coasts/stage1coastreforms.htm. This includes details about information seminars being held by OEH to further explain the reforms.

For further information, please contact Mike Sharpin, Manager, Urban and Coastal Water Strategy, on (02) 9995 6068.

Yours sincerely

Robyn Parker MP 24/10/12
Minister for the Environment

Level 32, Governor Macquarie Tower, 1 Farrer Place, Sydney NSW 2000
Phone: (61 2) 9228 5253 Fax: (61 2) 9228 5763 Email: office@parker.minister.nsw.gov.au